

Application Software Manual

FlowPilot



FLOWPILOT

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1 Introduction

1.1 About this Manual

The application software manual describes the FlowPilot scheduling software. It is intended to help operators become comfortable with FlowPilot features.

1.2 Intended Use

FlowPilot is a software product intended to support automated laboratory workflows by scheduling, orchestrating, and monitoring laboratory devices, methods, plates, and runs in various laboratory environments.

FlowPilot does not act as standalone software, is not a medical device, and has no medical purpose. FlowPilot does not directly interact with patients or parts of the human body. Any interaction with biological samples is performed by connected laboratory instruments. FlowPilot is distributed and intended for Research Use Only and not for use in diagnostic procedures.

The users of FlowPilot are trained laboratory personnel — operators, key operators and administrators — as well as Tecan service and support personnel, working in professional laboratory environments.

1.3 Definitions/Abbreviations

The following abbreviations/acronyms will be used throughout this document:

- **System Layout:** Devices configured for use on the automation system, including associated device settings.
- **Method:** A user-generated set of Method Steps that represent an assay/process.
- **Method Step:** A pre-defined set of automation actions used to fulfill the device function. Parameters collected on each step define how the step is completed.
- **Scheduler:** Proprietary software that schedules and executes all operations required to complete the Method.
- **Device Driver:** Distributed software that provides the bridge between FlowPilot and the physical lab equipment. Device Drivers are designed and provided by Service Provider.

1.4 Safety Notices and Symbols

This manual uses the following safety notice. Read it before performing the described action and follow the stated measure.

Each safety notice states the signal word, the hazard, the possible consequence and, where applicable, the measure to be taken:

Tab. 1: Signal Word

Signal Word	Meaning
NOTICE	Indicates a situation that is not hazard-related but, if not avoided, could result in damage to or malfunctioning of the equipment, or incorrect process results.

Safety Symbol



General mandatory action

1.5 Preface

The FlowPilot scheduling software automates the processing of microtiter (microwell) plates or other labware ("plates"). Plates are moved between storage devices and laboratory instruments using robotic arms. A Method is easily designed by the operator using a drag-and-drop editor. To schedule an assay run, the operator selects the Method and the plates to be processed. Detailed plate movements are then automatically scheduled and carried out by FlowPilot. The detailed plate movements include plate orientation, lid movement and removal, barcode reading, hand-off between robotic cells and incubator/storage system control. This helps scientists and lab operators significantly increase throughput and productivity compared to manual processes.

1.6 Residual Risks

The following risks cannot be eliminated by FlowPilot. Review these risks before operating the system:

- **Unintended Motion of Robotic Devices:**
Protection against physical injury relies entirely on hardware safety features (work cell enclosures, door locks, physical E-stops) supplied by Tecan or the system integrator—not on FlowPilot.
- **Error Recovery:**
Improper error recovery may lead to assay abortion, equipment damage or loss of reagents. Refer to ["Error Recovery" \[91\]](#).
- **IT Security:**
For cybersecurity risks and compensating controls, refer to the Secure Operating Manual (Doc ID: 403524), section "Residual Risks and Compensating Controls."

1.7 Design

FlowPilot is a web application that is accessed through a web browser. It was designed using a responsive page layout and may be accessed across a local network on a mobile device if desired.

Server Recommendations:

- Windows 11 IoT Enterprise LTSC 2024
- 2 Core CPU
- 8+ GB RAM
- 250GB+ Free disk space

1.8 Functional Areas

The following functional areas will be discussed in this document:

- System Layout
- Method Editor
- Plate Inventory
- Scheduling
- Device Drivers
- Administration

2 System Layout

The System Layout is a set of hardware devices configured on the system. This includes robotic arm(s), storage devices (such as a carousel, room-temperature hotel, incubator, or multi-position shaker), laboratory instruments, and handoff positions. The System Layout is usually configured during installation and only needs to be changed when the system hardware changes.

2.1 System Configuration

The System Layout is defined as a hierarchical structure with robots as root nodes. All storage devices and instruments are defined as children of a single robot. A robot must have unobstructed access and reach to all required child stations and nests. A system may have multiple robots. Each robot and specified child devices are referred to as a robotic work cell. To move a plate between robotic work cells, handoff nests must be configured. Nests are considered a one-way transfer; a system that has 2 robots and needs to move plates interchangeably must have a handoff nest defined for transfer between robot 1 and 2, and a nest defined for transfer between robot 2 and 1.

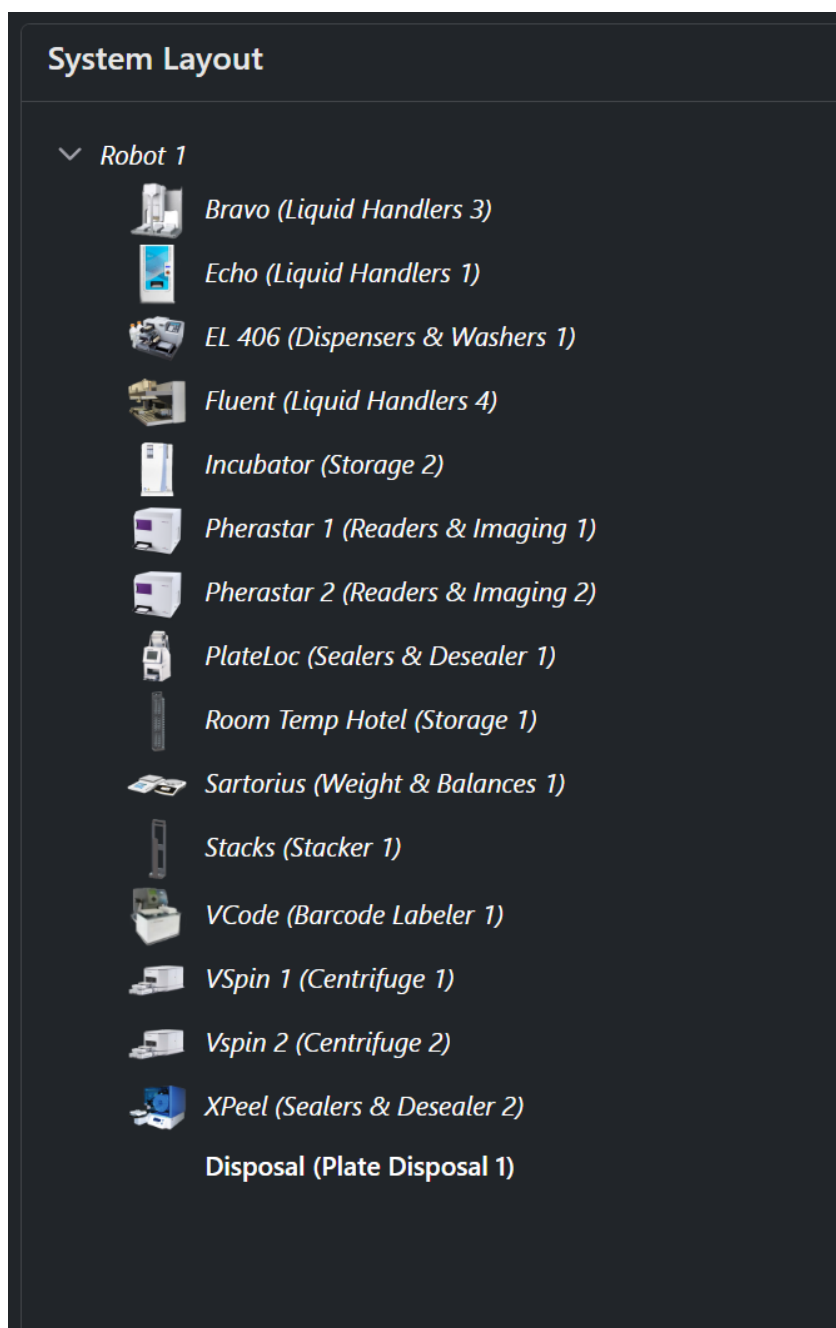


Fig. 1: System Layout

As an example, Figure 1 defines the following System Layout:

- 1 Robot Arm
- 1 Auxiliary Hotel
- 1 Incubator
- 2 Centrifuges
- 1 Desealer
- 1 Sealer

- 1 Dispenser (BioTek 406)
- 2 Readers (PHERASStar)
- 3 Liquid Handlers (1 Tecan Fluent, 1 Echo, 1 Bravo)
- 1 Balance
- Stacker

2.2 System Layout Editor

The System Layout Editor is accessed via the Admin menu. The editor consists of a Device Library and the currently configured System Layout.

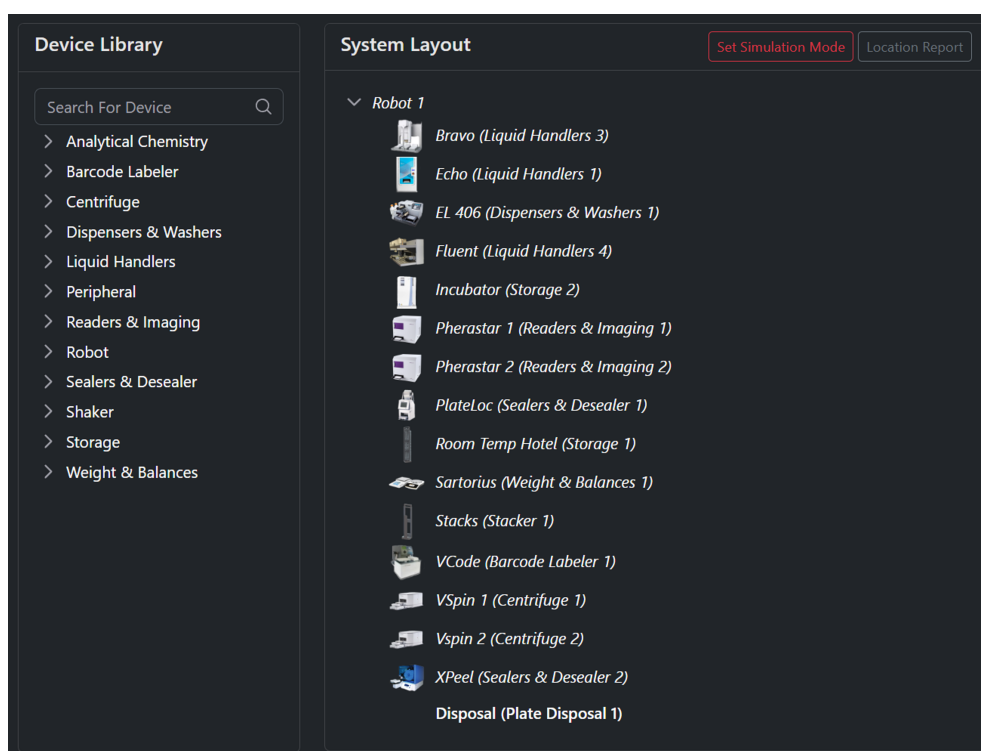


Fig. 2: System Layout Editor

2.2.1 Device Library

The Device Library is located on the left-hand side of the system layout screen. It contains all devices that have been configured to then be added to the system layout.

2.2.2 System Layout

The configured System Layout is displayed on the right side of the screen. Any changes (add/update/delete) of devices and settings will immediately be saved. For any new/updated devices to be recognized by the scheduler, the operator must either restart the scheduler or re-initialize the individual device. If no assay run is in progress, the operator can right click the device and select "Initialize Device" or "Re-Initialize Device"; this will apply the changes within the scheduler and allow the

device to be used within an assay. When an assay is running, the only way to have changes to the system layout applied within the scheduler is to restart the scheduler.



If there are any assays running during a scheduler restart, they will be immediately stopped and any plates in progress will remain at their current location and must be rehommed manually or using the robot.

2.2.2.1 Device Configuration

To add a device to the System Layout, the user will need to select the item from the device library, drag it to the current System Layout and drop it under the desired robot. A device settings screen will display that allows the user to configure the device. By default, all new devices will have simulation mode enabled.

To edit an existing device's settings, the user will double-click the device, and the settings screen will display. Any changes will persist when the Save button is clicked; if the Close button is clicked, any changes will be discarded.

The following fields exist on most device configurations:

- **Custom Device Name:** A customer specified pseudonym for the device for easier identification.
- **Processor Type:** Indicates the communication method supported by the driver.
- **Enable Pooling:** Enables devices to be pooled. Devices that have pooling enabled will be grouped by specific device type (e.g., all VSpins). If a device has multiple nests configured, the pool will use the minimum common number of nests between devices (e.g., if Fluent one has 5 nests and Fluent two has 7 nests configured, the pooled step will only allow the first 5 nests to be loaded during an assay).
- **Pool Group:** If pooling is enabled, devices can be grouped into smaller sub-groups if desired by entering unique sub-group names in this field. If left empty, all devices that are pooled will be selectable on the method step.
- **Allow Dispose:** If the device has more than 1 nest, this can be used to specify if a plate that is dropped off on the device can be disposed as part of the device protocol (e.g. disposing of a used tip box on a Fluent as part of the FluentControl protocol). When set to Yes, the user will be able to specify during method creation if the plate is not returned from the device.
- **Is Incubation Location:** Allow the device to be selected as an incubation location in Incubate method steps (only available for single-nest devices)
- **Simulation Mode:** When Yes, the scheduler will not connect to the device. Plates will be brought to the device location and device actions will be simulated if a run is started.
- **Priority:** Sets the relative priority of this device against other devices in the system layout.
- **Use Https:** When Yes, uses an SSL secured channel to connect to the driver.
- **IP Address:** IP Address of the device driver.
- **Port:** Port of the device driver.
- **Network Timeout:** Length of time (milliseconds) for the device to respond to FlowPilot when queried for status.

- **Network Retries:** Number of Network Timeouts that must be missed before a fault state is set for the device.
- **Loop Rate (Socket driver):** Amount of time (milliseconds) between processing loops for the device.
- **Status Check Time (Http driver):** Amount of time (milliseconds) FlowPilot will wait before requesting a status update from the remote driver.
- **Heartbeat Frequency (Http driver):** Amount of time (seconds) between each driver up heartbeat check.
- **Nest Configuration:** Defines the number of nests available on a given device and allows the user to specify nest labels that are used when configuring plates in a method. Most devices require at least one nest; there is a special “Data” device classification that allows for special purpose drivers and an associated “Data” device to be configured. These devices expect that no plates will ever be moved to the device and are only used for the purpose of data creation/ exchange.

VSpin 1 (Centrifuge 1)

General

Custom Device Name
VSpin 1
Give a custom name to the device

Processor Type
☐ Socket ☒ Http

Enable Pooling
☐ Yes ☒ No
For devices to participate in a pool, they must be the same Device Type and have the same Nest Configuration setup

Allow Dispose
☐ Yes ☒ No
Allow the disposal of plates on this device during method steps

Pool Group
Setup pool group if applicable

Driver Details

Simulation Mode
☒ Yes ☐ No

Use Https
☐ Yes ☒ No

Port
7001

Network Retries
3

Heartbeat Frequency
60
Number of seconds between each connection heartbeat

Priority
Normal

IP Address
127.0.0.1

Network Timeout
10000

Status Check Time
1000
Time in milliseconds between driver status requests

Nest Configuration

Primary Robot Location
13

Additional Robot Location
14

Primary Nest Label
Primary Nest

Additional Nest Label(s)
1

Index	Label
1	Source Nest

Save Close

Fig. 3: Device Settings

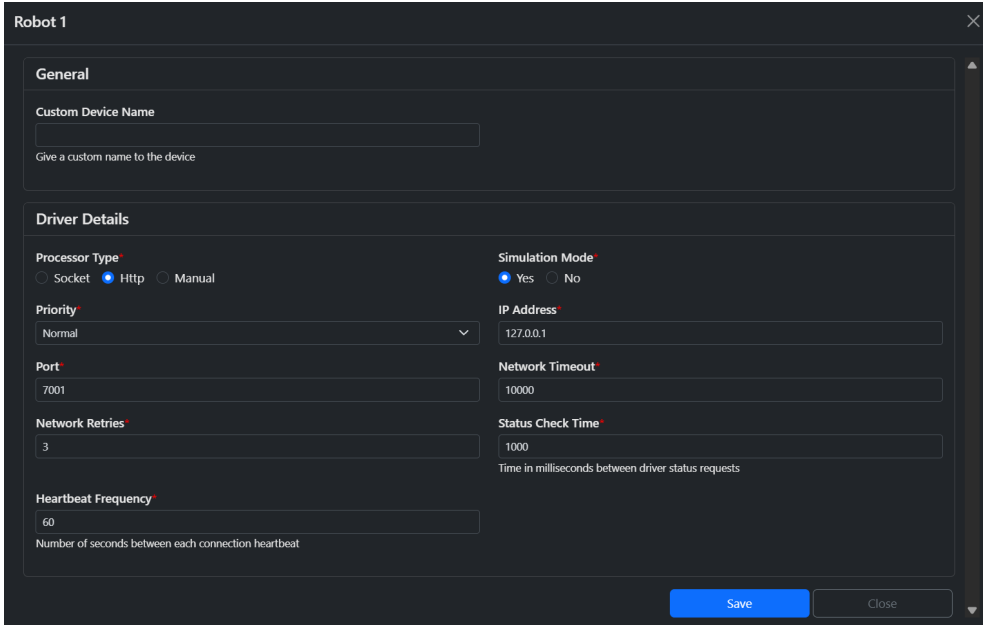
Additional configuration options are available by right-clicking on the device name in the System Layout. The following options will be displayed:

- **Delete Device:** Deletes the device from the System Layout.
- **Disable/Restore Device:** Disables or Restores the device. Used with device carts to dynamically add/remove a device from the system, or when a device is not online and should not be used in a running assay.
- **Initialize/Re-Initialize Device:** If no assay is running, will re-initialize the communication between FlowPilot and the device driver, applying any changes that were made during configuration.
- **Set/Remove Simulation Mode:** Changes the simulation mode of the device. If no assays are running, it will automatically place in simulation mode. Will require the user to either re-initialize the device or restart the scheduler to fully restore communication.

2.2.2.2 Robot Configuration

Robots are added/edited using the same process as a general device. Additional configuration options are available by right-clicking on the robot's name in the System Layout. The following options may be displayed:

- **Delete Device:** Deletes the device from the System Layout. Deleting a robot will delete the robot and all child devices from the System Layout.
- **Set/Remove Simulation Mode:** Changes the simulation mode of the robot. If no assays are running, it will automatically place in simulation mode. Will require the user to either re-initialize the device or restart the scheduler to fully restore communication.
- **Add Plate Disposal:** Plate disposals are used as disposal nests at the end of an assay for a particular robot.
- **Add Handoff (XX to YY):** Only available if more than one robot has been configured in the system layout, and a handoff has not already been configured. Hand Offs are required to move plates between robots.



The image shows a configuration window titled "Robot 1" with a close button (X) in the top right corner. The window is divided into two main sections: "General" and "Driver Details".

General

Custom Device Name
Give a custom name to the device

Driver Details

Processor Type: ☐ Socket ☒ Http ☐ Manual

Simulation Mode: ☒ Yes ☐ No

Priority: Normal (dropdown menu)

IP Address: 127.0.0.1

Port: 7001

Network Timeout: 10000

Network Retries: 3

Status Check Time: 1000
Time in milliseconds between driver status requests

Heartbeat Frequency: 60
Number of seconds between each connection heartbeat

At the bottom right, there are two buttons: "Save" (blue) and "Close" (grey).

Fig. 4: Robot Settings

2.2.2.3 Random Access Storage Configuration

Random Access Storage devices are configured by entering the capacity of each individual stack. Modifying the individual stack capacity will update the total capacity. To the right of the add/remove stack is an input that allows the user to modify default stack size for all new stacks added.

Room Temp Hotel (Storage 1)

General

Custom Device Name: Room Temp Hotel
Prevent Plate Disposal: ☐ Yes ☒ No

Robot Location

Robot Location: 1

Configuration

Number of Stacks: 4 (with + and - buttons) 27
Total Shelves: 100

Stack	Shelves
1	25
2	25
3	25
4	25

Save Close

Fig. 5: Storage Configuration

2.2.2.4 Stacker Storage Configuration

Stacker Storage devices are configured by entering the height (in millimeters) and the maximum number of plates that may fit in the stacker. The actual number of plates that can fit in each stack is determined by using the stacked plate type (or lidded stacked plate height) of the plate type that is assigned to the stack at run time. The maximum number of plates field will limit the number of plates if the calculated plate capacity is larger than the maximum entered.

Stacks (Stacker 1)

General

Custom Device Name

Stacks

Give a custom name to the device

Robot Location

Robot Location*

19

Configuration

Number of Stacks*

+

-

400

28

Stack	Height (mm)	Maximum # of Plates
1	400	28
2	400	28
3	400	28
4	400	28

Save

Close

Fig. 6: Stacker Configuration

2.2.2.5 Simulation Mode

When a device has Simulation Mode enabled in the System Layout, FlowPilot will not send commands to the device driver, instead it allows FlowPilot to simulate interacting with the desired device. This is generally only used for testing a new device or when a device is offline and it is not desirable to disable the device on the System Layout.

Additionally, there is a “Set Simulation Mode” button at the top of the System Layout section that allows the user to set Simulation Mode for all devices in the System Layout (scheduler restart is required).

2.3 Robot Location Report

A Robot Location Report button is available at the top of the system layout display that will generate a simplified report containing all robot locations used for each robot. This report is a simplified view that assists a user when training robot nest locations.

Robot Location Report		✕
Location	Device	
Robot 1		
21 - Primary 22 - Additional [Capacity: 3]	Bravo	
3 - Primary 4 - Additional [Capacity: 1]	Echo	
2 - Primary	EL 406	
23 - Primary 24 - Additional [Capacity: 4]	Fluent	
6	Incubator Transfer Nest Count: 1	
9 - Primary	Pherastar 1	
10 - Primary	Pherastar 2	
11 - Primary	PlateLoc	
1	Room Temp Hotel Capacity: 100 Shelves: 4 - [25, 25, 25, 25]	
20 - Primary	Sartorius	
19	Stacks Stacks: 4	
18 - Primary	VCode	
13 - Primary 14 - Additional [Capacity: 1]	VSpin 1	
15 - Primary 16 - Additional [Capacity: 1]	Vspin 2	
12 - Primary	XPeel	
17	Plate Disposal 1	

Fig. 7: Example Robot Location Report

2.4 Security

The following role permissions are available to control access to the System Layout:

- **View System Layout:** Allows the user to view the System Layout screen and menu item.
- **Edit System Layout:** Allows the user to modify the System Layout.

- **Modify Robot Locations:** Allows the user to change the robot location number(s) for a device. Should only be assigned/used by operators that are configuring the robot driver.
- **Can Disable/Enable Device:** Allows the user to disable or enable devices on the System Layout.
- **Initialize Device:** Allows the user to Initialize or Re-Initialize a device on the system layout.
- **Change Simulation Mode:** Allows the user to modify the Simulation Mode of a device on the System Layout without requiring full edit ability.
- **Lock Devices:** Allows the user to request exclusive access to a device on the active system layout. Normally used during a run to prevent usage for device maintenance (e.g. changing reagent).
- **Manage Scheduler:** Allows the user to restart the scheduler after changes to the System Layout have been made.

3 Method Editor

To run an assay, the user must first create a method file. The method file contains the list of Method Steps and parameters that define the assay. The Method Editor enables a visual approach to creating and configuring the method file. The Method Editor is accessed via the menu and consists of a list of available method steps, method file selection, and the method editor. Users may view any method file that has been created.

When a method is created, the user is not concerned about the physical location of the plates at method start as they will be selected when the run is scheduled. Instead, the user should focus on what a single iteration of the method should accomplish and the flow of plates between devices.

3.1 File Selection

On initial load of the method editor, the user will be prompted to either load an existing file or create a new file. Method files by default are associated with specific users (viewed as a folder within the file selection). A user may view a method file located in any folder.

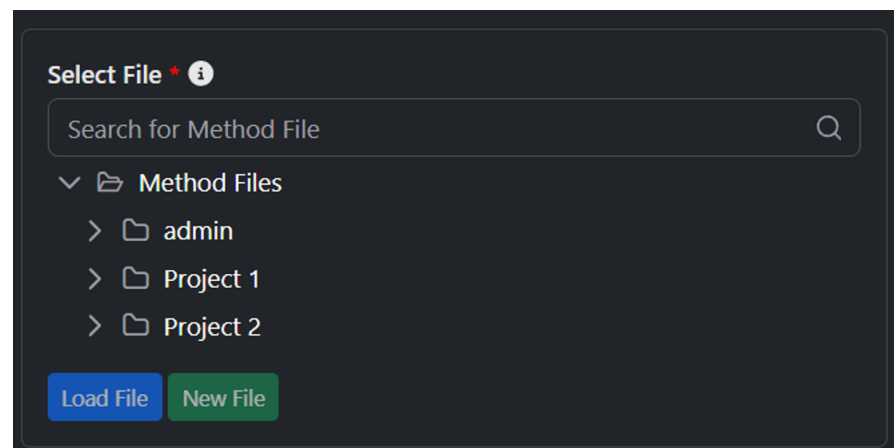


Fig. 8: Method File Selection

A user may select an existing file to edit by selecting the file and clicking “Load File” or double-clicking on the desired file. A file or folder may be deleted by a user by right clicking the selected item and selecting the “Delete” option on the menu that appears. If a user does not have proper security permissions, only files and folders in their user-based folder may be deleted.

3.1.1 New Folder/File Creation

To create a new folder/sub-folder, the user must select the parent folder and right click. A menu will appear that allows the user to select “New Folder”. A window will display that allows the user to enter a unique folder name.

To create a new file, the user must select the folder where the file will reside and click “New File”. A window will display requiring the user to enter a unique file name. The system will append the appropriate file extension.

If the user has proper security permissions, the user may create new files and folders at any location. Otherwise, the user is limited to creating new files and folders in their user-based folder.

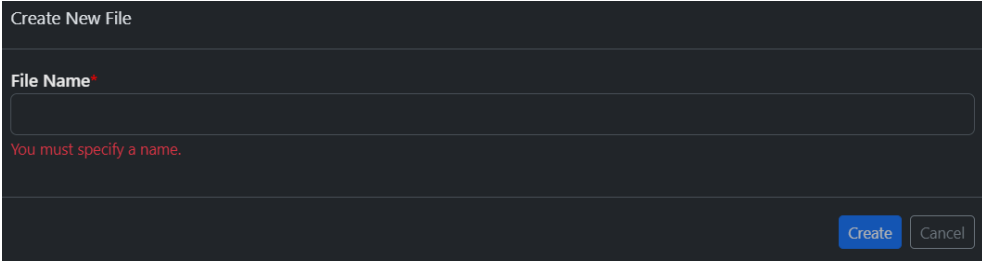
A dark-themed dialog box titled "Create New File". It features a text input field labeled "File Name" with a red asterisk indicating it is required. Below the input field, a red error message reads "You must specify a name.". At the bottom right, there are two buttons: a blue "Create" button and a grey "Cancel" button.

Fig. 9: New File Dialog

3.2 Available Method Steps

The available Method Steps will be displayed on the left hand of Method Editor once a method has been loaded. Only Method Steps associated with devices configured in the System Layout will be displayed. Each Method Step is associated with a specific device as annotated on the step display. Depending on if the method has plates defined, steps that use plates may be hidden. To add a step to the Method, the user will click on the desired step, enter desired parameters, click Save, and the step will be automatically added to the end of the Method. If a step should be appended to a different step in the method, the user should select the desired parent step before adding the new step.

In the event the System Layout contains many devices, the user can filter the available steps by entering a portion of the device name or step type. To clear the filter, the user will remove the text from the search box.

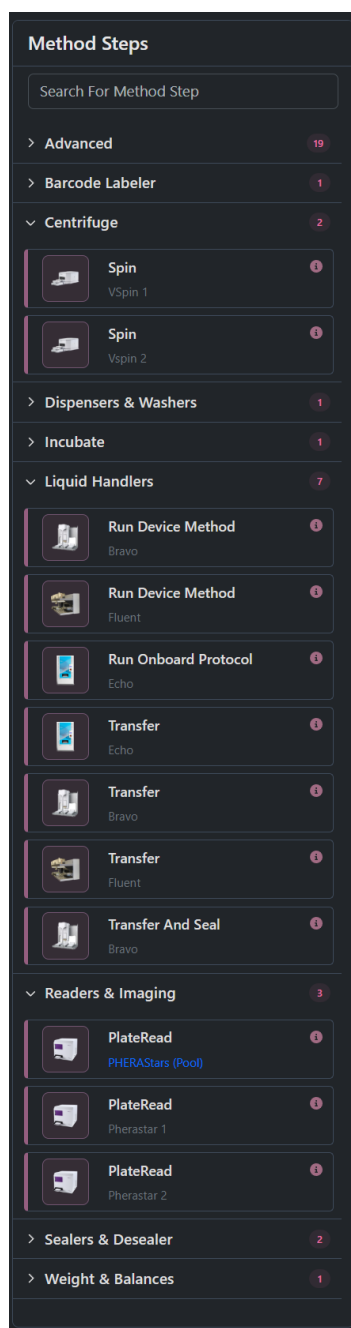


Fig. 10: Available Method Steps

3.3 General Method Step Types

As discussed in section 3.2, the available method steps are dependent on the devices that are configured on the System Layout. FlowPilot comes with a certain number of general method steps that cover advanced usages and incubation that are discussed in this section.

3.3.1 Approval/Prompt Step

The Approval and Prompt steps are similar but serve slightly different purposes. The prompt step is used to display information to the operator while requiring an acknowledgment before proceeding. The approval step additionally gives the operator the option to Fault the iteration or the entire run; for instance, if there is a plate read step, the approval step could be used to prompt the operator to approve the read results before proceeding with further assay steps on a given iteration.

For both steps, the user will specify text that is displayed and can optionally upload an image (10MB max) and/or video (20MB max) to display. Advanced Execution Control can be used to determine if the prompt/approval needs to be displayed on all iterations, just the first iteration, or some other frequency. The user should decide if the entire assay should be paused until the prompt/approval is handled/acknowledged; if not paused, other iterations will continue to run. For example, if the desire is to prompt on the first iteration to ensure all reagents are in place prior to the start of the run, the user should use the Advanced Execution Control to prompt on the first iteration only and set "Pause Assay Until Handled" to Yes.

The screenshot shows the 'Approval' configuration window. It is divided into three main sections: 'Approval Parameters', 'Step Execution', and 'FlowPilot Parameters'. In the 'Approval Parameters' section, there is a text area for 'Approval Text' with a red asterisk indicating it is required. Below it, a red message states 'Approval Text is required'. There are two columns for optional media: 'Optional Image' and 'Optional Video', each with an 'Upload File' button and a checkbox for 'Upload When Scheduling Run'. The 'Pause Assay Until Handled' section has two radio buttons, 'Yes' and 'No', with 'No' selected. The 'Step Execution' section contains a dropdown for 'Use Advanced Execution Control' set to 'No'. The 'FlowPilot Parameters' section has a text field for 'Step Name' containing the word 'Approval'. At the bottom right, there are 'Save' and 'Close' buttons.

Fig. 11: Approval Step

×

Prompt Parameters

Prompt Text*

Prompt Text is required

Optional Image

Upload File

☐ Upload When Scheduling Run ⓘ

Optional Video

Upload File

☐ Upload When Scheduling Run ⓘ

Collect Parameter(s) From Operator

Collect Parameters for Iteration or All*

☒ Iteration Only
 ☐ All Iterations

Pause Assay Until Handled*

☐ Yes
 ☒ No

Set I/O Controls

No I/O System Controls available.

Step Execution

Use Advanced Execution Control*

No

FlowPilot Parameters

Step Name*

Prompt

Save

Close

Fig. 12: Prompt Step

The prompt step can additionally be used to collect parameters from the operator if the method is using parameters. If the parameter(s) to be collected are iteration-scoped, then all iterations will be displayed when the operator is prompted to enter values.

The prompt step can also be used to update the state of one or more digital I/O controls before the prompt is shown and after it is acknowledged. These options are only available when at least one I/O control has been defined in the I/O Configuration. The assignment of I/O controls works the same as in the Set I/O method step. In the prompt that is shown to the user, the controls that were set and the controls that are set after the prompt is acknowledged are displayed together

with the old and new values of the controls. Please note that the assay run does not wait for the prompt to be acknowledged unless the existing “Pause Assay Until Handled” option in the method step is set accordingly.

Both the Approval and Prompt text input by the user supports the use of Tokens; see the Log Step for further information.

3.3.2 Cache Plate Step

The Cache Plate Step is used as an optimization to temporarily move plates to a new location; this can be helpful in multi-robot systems or when a plate is homed in a storage device that has a long loading/unloading time. When using the Cache Plate step, the user should always use them in sets of two, a Set Cache and a Clear Cache step. To set the cache location, the user would use the Cache Operation “Set Cache Location”, select the desired Cache Location, and specify if the move should occur immediately or during the next organic plate move. To clear the cache, set the Cache Operation to “Clear Cache Location” and specify if the plate move should occur immediately. When using the Cache Plate steps, the operator must ensure that the cache location has enough storage available for the number of plates being used in the run, or the throttle option must be used to ensure the storage will be sufficient throughout the run.

Delaying the move of the plate when setting or clearing the cache location is often used as an additional optimization but is highly dependent on how the method is designed. For instance, if a plate is cached in a storage location without being moved immediately and then sent to Dispenser A, the plate will have a location reserved in the cached storage location, move to Dispenser A, and on completion of the Dispenser A step, will be moved to the cached location that was reserved. If the plate had originally been moved as part of the cache, it would be moved to the cache prior to being moved to the Dispenser.

The screenshot shows the 'Cache Plate' configuration window. It is divided into several sections: 'Cache Parameters' with dropdowns for 'Cache Operation' and 'Cache Location', and a 'Move Plate on Cache Step' dropdown set to 'No'; 'Step Execution' with a 'Use Advanced Execution Control' dropdown set to 'No'; 'FlowPilot Parameters' with a 'Step Name' field containing 'Cache Plate', a 'Priority' slider set to 'Normal', and a 'Load Simulation Time' field set to '10'; and 'Loading Pattern' with a 'Selected Plate' dropdown set to '(1) Plate #1'. 'Save' and 'Close' buttons are at the bottom right.

Fig. 13: Cache Plate Step

3.3.3 Conditional Branch Step

When a method has a set of steps that need to be conditionally executed, use the Condition Begin/End set of steps. The user will give each Condition Begin step a unique "Condition Name," and reference that name in the Condition End step. Executing a condition branch is controlled by Method Parameters. Parameters can be updated using a Script step, Prompt Step, Set Parameter step, or from automatic driver updates. If the specified condition is not met, all steps between the Condition Begin and Condition End steps will not be executed. Note that if a condition has a set of branched steps, and not all branches return to the Condition End step, all steps in the branch will not be executed.

Fig. 14: Conditional Branch Step

3.3.4 Executable Step

The Executable Step is used to call an external .bat or .exe file. Executables must be placed in the Executables folder in the FlowPilot installation directory with Windows File Explorer. The executables in that folder appear as options for the Executable parameter in the UI.

- **Executable:** The .exe or .bat file to run.
- **Executable Arguments:** A string passed to the .exe or .bat that can be used to supply arguments specific to that application for changing behavior.
- **Wait For Process Completion:** Determines if the step runs the application and completes the step or waits for the application to terminate before completing the step. This must be Yes for Return Assignment to be visible.
- **Return Assignment:** If the step waits for completion, this is the method parameter that the return value of the application is assigned to. The parameter must be the only text on the last line of the standard output of the application. The string must be in a format that matches the type of the parameter.
 - **Boolean Format:** True or false in any casing.
 - **Decimal:** 16-byte floating point value (range $\pm 1.0 \times 10^{-28}$ to $\pm 7.9228 \times 10^{28}$).

- **String:** Any string value.
- **Integer:** Any valid 64-bit integer (range -9.22×10^{18} to 9.22×10^{18}).
- **Time:** Total seconds (e.g. 3600 for one hour, 60 for a minute).

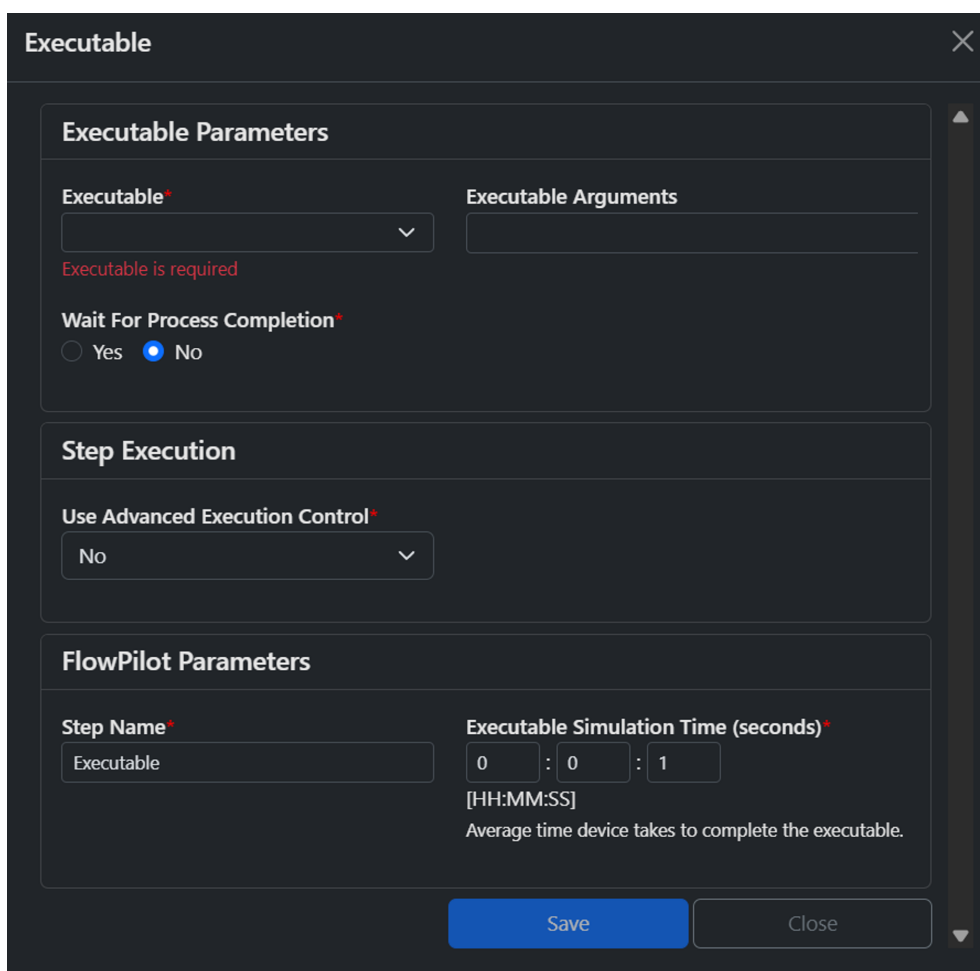


Fig. 15: Executable Step

3.3.5 Hold Iteration Step

The Hold Iteration method step allows the operator to insert a stop point that will prevent further progress until the specified parameter conditions have been met. If multiple parameters are listed, all conditions must be met for the hold to be considered complete.

Additionally, the operator will be prompted to enter Timeout and Timeout Action. When the Hold Iteration step is started, a timer will be started by FlowPilot in the background; if the timer exceeds the Timeout value specified, the step will end regardless of the specified condition being met. When a timeout is exceeded, the behavior depends on the option the user selected for the Timeout Action field.

Timeout Action behavior:

- **Continue Iteration:** Child steps will continue as if the step conditions had been met.
- **Cancel Child Steps:** All child steps will be cancelled and not be processed.

Hold Iteration

Hold Until All Parameters Match

+ Add Parameter

Parameter*
--Select Parameter--

Hold Parameters

Timeout*
0 : 0 : 0 : 0
[DD:HH:MM:SS]
Timeout is required

Timeout Action*
Continue Iteration

Step Execution

Use Advanced Execution Control*
No

FlowPilot Parameters

Step Name*
Hold Iteration

Priority (Normal) ⓘ
Lowest Highest

Save Close

Fig. 16: Hold Iteration Step

3.3.6 Incubate Step

The Incubate Step is used when a plate needs to be incubated in a specified location for a certain amount of time. When incubating a plate, the user must select the time to incubate and the location the plate should be incubated. By default, the plate will be incubated at its home location, but the user may choose any other storage location. It is important when running the assay that the storage location has enough space available for the number of plates; otherwise, the user should throttle the run to the maximum number of spaces available.

The user must also specify the behavior of the incubation timer if the scheduler is suspended during an incubation step (e.g., a fault occurs that requires operator response). If the user opts to stop the incubation timer, the amount of time the scheduler is suspended will not be counted as part of the incubation time. For example, if the incubation time is 1 hour, and the scheduler is suspended for 5 minutes during the incubation period, the actual time the plate will be incubating will be 1 hour 5 minutes.

The user has the option to set a Maximum Incubate Time; if a plate exceeds the maximum time specified, the user can either be notified or the iteration can be faulted. If the iteration is faulted, the plate can either be returned to its home location or disposed of in the specified disposal location. When this option is used and the time is exceeded, the plate will be returned home/disposed on the next scheduled move of the plate, not when the maximum time is initially reached.

Additionally, an Incubation Prompt can be configured at a specific interval before the end of the incubation period (e.g., if a 1-hour incubation period is specified with a 5 min prompt time, the prompt will occur 55 minutes into the incubation). If used, it is important to note that the incubation step will not complete until the prompt is acknowledged by the operator; this means that an unacknowledged prompt can lead to incubation overages. Additionally, the prompt can be configured to only be displayed on the first iteration of the run or on all iterations. Incubation prompts are typically used in cases where manual operator interaction is required before the plate proceeds to the next step (e.g. new reagent is loaded on the dispenser).

Incubate

Incubation Parameters

Incubate Time*

0 : 0 : 0

[DD:HH:MM:SS]

Incubate Time is required

Stop Incubation Timer when FlowPilot is Suspended*

☒ Yes ☐ No

Set Incubation Max Time*

☐ Yes ☒ No

Incubation Location

Choose Incubation Station*

Incubate plate in original location

Specified Location*

Prompt

Prompt operator before incubate timer expires*

☐ Yes ☒ No

Prompt Time*

0 : 0 : 0

[HH:MM:SS]

Time before end of incubate period to prompt user.

Prompt Text*

Only Prompt on First Iteration*

☐ Yes ☒ No

Step Execution

Use Advanced Execution Control*

No

Loading Pattern

Selected Plate*

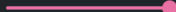
(1) Plate #1

FlowPilot Parameters

Step Name*

Incubate

Priority (Normal) ⓘ

Lowest  Highest

Load Simulation Time (seconds) *

0 : 0 : 30

[HH:MM:SS]

Average time robot takes to move and load plate in device.

Unload Simulation Time (seconds) *

0 : 0 : 30

[HH:MM:SS]

Average time robot takes to unload and move plate from device.

Barcode Verification*

None

After Step Complete*

Return Primary plate to home location

Save

Close

Fig. 17: Incubate Step

3.3.7 Link Begin/End Step

The Link Begin/End steps will always be used in pairs within the method and are designed to be used as a single iteration throttle within the assay. When a Link begin step is used, a unique “Group Name” within the method is created that will be selected in the Link End step to close the throttle. When a link step is encountered, only 1 iteration of the assay is allowed to enter that section until the Link End step has been completed (note: if the same Group Name is used across methods, the link steps can be used as a throttle across assay runs). This has the effect of treating all steps within the Link Begin/End steps as one grouped step; however, this does not reserve all the devices up front, so if a device is used elsewhere in the method (or in another running assay), it will not prevent that device from being used elsewhere.

As examples, the Link steps can be helpful in the following scenarios (given the above limitations noted):

- **Plate Replication:** If replicating a plate and there are more replicants needed than nests available on the liquid handler, multiple liquid handler steps can be linked to ensure that all replications occur before the next iteration begins replication.
- **Dispense/Incubate/Read:** If there is specific time between dispensing and reading a plate, linking the dispense, incubate, and read steps can ensure that the reader is available at the specified time after the dispense.

The screenshot shows the 'Link - Begin' configuration window. It is divided into three main sections. The first section, 'Group Parameters', contains a text input for 'Group Name' which is marked as required. Below the input is a message: 'Enter a unique step group name' and a red error message 'Group Name is required'. The second section, 'Step Execution', contains a dropdown menu for 'Use Advanced Execution Control' which is currently set to 'No'. The third section, 'FlowPilot Parameters', contains a text input for 'Step Name' which is pre-filled with 'Link - Begin'. At the bottom right of the window are two buttons: 'Save' and 'Close'.

Fig. 18: Link Begin Step

3.3.8 Log Step

The Log step is specifically used for logging additional information to the run logs. The text entered in the step will be added to the run logs. When entering the log text, the user may use tokens to insert run data into the text at the time the log is written. The token should be included in the template string by including curly braces {} around the token name where the value should be input (e.g.: "Logged text for Run #{RunId}, Iteration {Iteration} occurred at {Now}."). The following tokens have been made available for the user:

- **Barcode:** The primary plate barcode of the iteration being run.
- **Barcode.n:** Any valid additional barcode for the iteration. If you wanted the 3rd Method Plate barcode for the iteration, 'Barcode.3' would be used. Note, 'Barcode.1' is not valid, and should be accessed using the 'Barcode' token.
- **Iteration:** The Iteration being run.
- **RunId:** The run #.
- **ExternalId:** The external Id of the run input by the operator.
- **StepName:** The name of the log step entered by the method creator.
- **Now:** The current date time.
- **FirstIteration:** True/False if the iteration is the first iteration of the run.
- **LastIteration:** True/False if the iteration is the last iteration of the run.
- **Method Parameters:** Any defined method parameters can be accessed using the defined name of the parameter.

The screenshot shows a 'Log' configuration window with a dark theme. It contains three main sections: 'Log Parameters' with a 'Log Text' input field and a red error message 'Log Text is required'; 'Step Execution' with a 'Use Advanced Execution Control' dropdown menu set to 'No'; and 'FlowPilot Parameters' with a 'Step Name' input field containing the text 'Log'. At the bottom right are 'Save' and 'Close' buttons.

Fig. 19: Log Step

3.3.9 Loop Step

When a method has a set of steps that need to be repeated multiple times, use the Loop Begin/End set of steps. The user will give each Loop Begin step a unique "Loop Name," and reference that name in the Loop End step. Executing a loop branch is controlled by Method Parameters. Parameters can be updated using a Script step, Prompt step, Set Parameter step, or from automatic driver updates. If the specified condition is not met, all steps between the Loop Begin and Loop End steps will be repeated.

Fig. 20: Loop Begin Step

3.3.10 Move Plate Step

The Move Plate step allows the user to move a plate from its home location to a new location, either temporarily or as a home re-assignment. The user will specify the destination storage and if the plate is to be re-homed. If the plate is re-homed, the user can delay the move until the next organic plate movement. When using the Move Plate step, the operator must ensure that the destination storage device has enough storage available for the number of plates in the run.

The move plate step is typically used at the end of a run when a plate has been created/modified in such a way that the starting home location is no longer the appropriate location (e.g., an empty plate now has cells that belong in a specific incubator).

Move Plate

Move Plate Parameters

Destination Storage*

Rehome Plate*

Rehome Plate On Next Move*

Select yes to move the plate to the new home position on the next organic move. Select no to move immediately.

Step Execution

Use Advanced Execution Control*

FlowPilot Parameters

Step Name*

Priority (Normal) ⓘ

Load Simulation Time (seconds)*

Average time robot takes to move and load plate in device.

Loading Pattern

Selected Plate*

Save Close

Fig. 21: Move Plate Step

3.3.11 Plate Disposal Step

When a system has at least one designated plate disposal location, the Plate Disposal method step will be available. A Plate Disposal step must be placed after the last use of the plate during the run; when the method is saved, if the plate is used after the plate disposal step, FlowPilot will prevent saving the method until corrected.

During the run, when the Plate Disposal step is run, the plate will be delivered to the disposal location selected and the plate will be deleted from the inventory.

Fig. 22: Plate Disposal Step

3.3.12 Schedule Assay Step

The Schedule Assay step allows for another method to be started as a separate assay run as part of the method execution. For the method step to be available, the “Requires Plates Start in Home Position” option in the Application Settings needs to be turned off. Select the method to be run from the Select Method File area. The method selected needs to have the same number of plates or fewer defined as the containing method. The section “Schedule” allows the new method to be run immediately or scheduled with a delay. “Plate Selection” gives the option “This Iteration”, which would start the scheduled assay for the current iteration only and the option “All Iterations”, which would start the scheduled assay for all iterations of the current method. The section “Plate Mapping” allows to map the plates of the current method with the plates of the newly scheduled Assay. Assays scheduled from a method show up in the Current/Historical Runs on the Home page like normal assay runs but cannot be cloned and refer to the original assay run as their parent.

Schedule Assay

Schedule

Select Method File ^{*}

Search for Method File

Method Files

- admin
- operator
 - MyNewAssay
 - TestMethod

Selected File

- operator\MyNewAssay.mthjson

Schedule ^{*}

Immediate

Plate Selection ^{*}

This Iteration

Optimization Factor (55%) ⁱ

Throughput Consistency

Additional Plate Delay ⁱ

0 : 0 : 0

[HH:MM:SS]

Run Priority (Normal) ⁱ

Lowest Highest

Plate Mapping

DestinationPlate ^{*}

(1) AssayPlate

Step Execution

Use Advanced Execution Control ^{*}

No

FlowPilot Parameters

Step Name ^{*}

Schedule Assay

Save Close

Fig. 23: Schedule Assay Step

3.3.13 Script Step

The Script Step allows custom C# or Python code to be written and executed as part of the method execution. Detailed documentation covering the script step can be found in FlowPilot Documentation section and is not duplicated here. The dropdown menu allows a user to choose which language. Python must be setup for it to appear.

In addition to custom scripts, users can change the “Script Mode” option to select a predefined script from the Script library instead. Choosing to use a predefined script replaces the script text input with a table displaying the existing predefined scripts with their name and description. Clicking on a predefined script will select it, replacing the name and simulation time of the method step with the values defined for the script and preventing them from being edited while the script is selected. Clicking a selected script again or changing the script mode back to custom will unselect it.

Using the clone button (blue if enabled), a predefined script can be cloned to make changes to it that only apply to the current method step. When a script is cloned, the script mode is changed to custom and the script text is replaced with the text of the selected predefined script. The name and simulation time are also replaced, but can be edited afterwards.

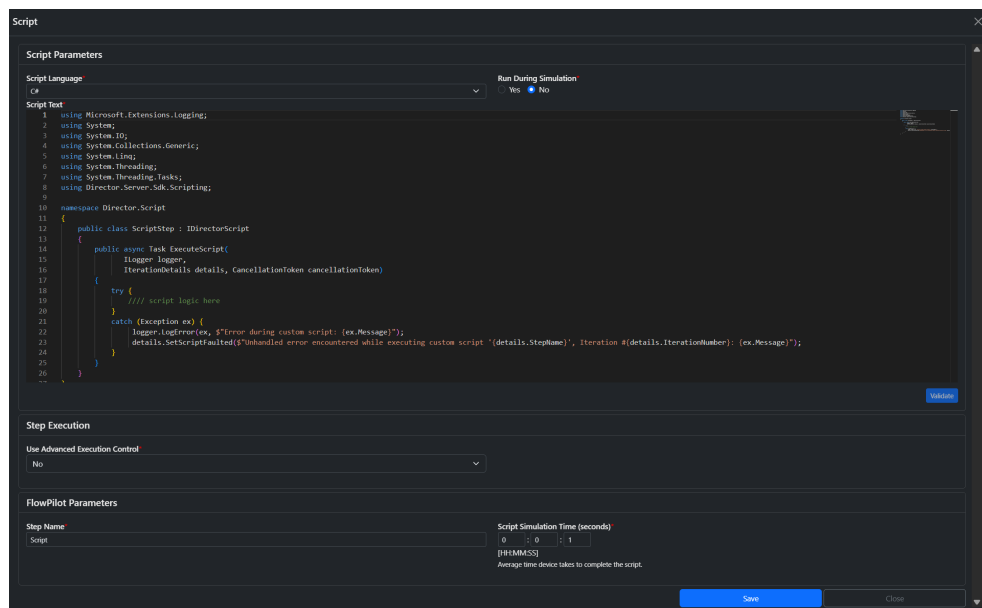


Fig. 24: Script Step

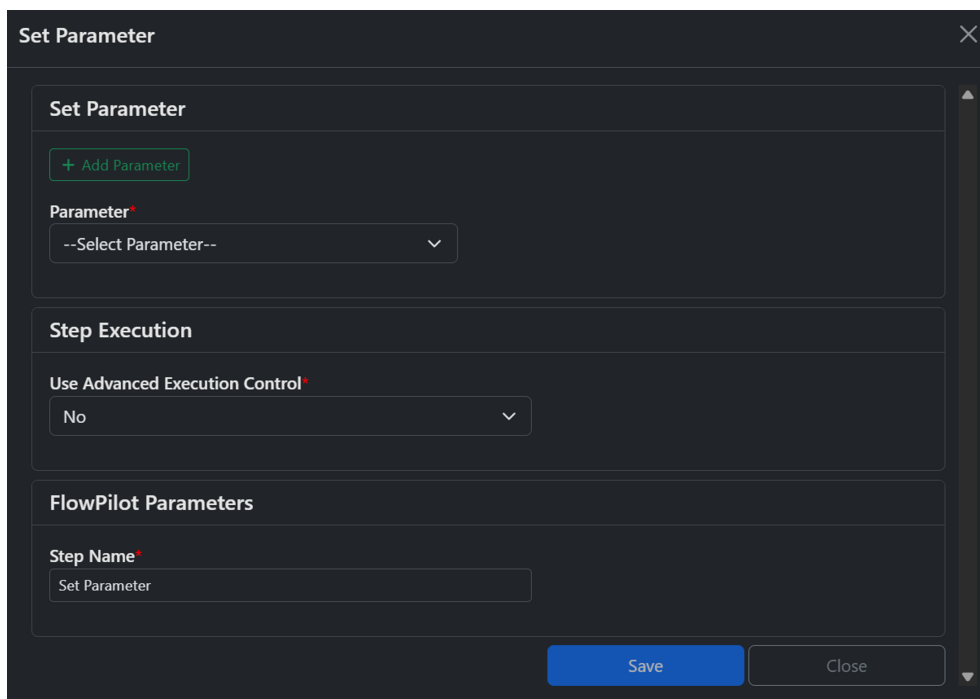
3.3.14 Set I/O Step

The Set I/O Step allows for the state of one or more digital I/O controls to be updated during the assay execution by the system. The Set I/O method step is only available when at least one I/O control has been defined in the I/O Configuration. The label of the toggle button for defining the value is determined by the control configuration. Set I/O method steps are not displayed in the timeline view, but are listed in the timeline data separately for each control together with the name and old/new value of the control.

3.3.15 Set Parameter Step

The Set Parameter Step allows one or more method parameters to be updated during the assay execution by the system. Each parameter can be updated in one of three ways:

- **Set To/Set Equal To:** Set the parameter to the specified value or calculation.
- **Increment By:** Only available on Integer or Decimal type parameters. Enter the value to increase the current value by.
- **Decrement By:** Only available on Integer or Decimal type parameters. Enter the value to decrease the current value by.



Set Parameter

+ Add Parameter

Parameter*

--Select Parameter--

Step Execution

Use Advanced Execution Control*

No

FlowPilot Parameters

Step Name*

Set Parameter

Save Close

Fig. 25: Set Parameter Step

3.3.16 Parameter Calculations

For integer, decimal and time parameters, the value can also be specified as a mathematical expression. The expressions allow parameter values to be calculated based on numerical values, operators, functions, and other method parameters. The exact options depend on the target parameter type:

- Integer
- Decimal
- Time

General rules

- Parameter names are not case sensitive.
- Expressions can include numbers, operators, parentheses, functions, and references to other parameters.
- Use parentheses to control evaluation order.
- Function names can be written in any casing, such as max, Max, or MAX.
- Only numeric parameters can be used in expressions. String or boolean parameters are not supported.

Referencing parameter values

Other numeric method parameters can be referenced as part of an expression.

Direct parameter reference

Parameter names can be referenced directly when the name is a simple identifier:

- It starts with a letter or underscore.
- It only contains letters, digits, or underscores.

Examples:

- Cycles + 1
- SampleCount * 2
- _Offset + 5

Curly brace parameter reference

Curly braces must be used when the parameter name contains spaces or special characters.

Examples:

- {Incubation Time}
- {Variable-Name}
- {Variable (Primary)}

Curly braces are required when the parameter name contains characters such as spaces, hyphens, parenthesis or other characters that may otherwise be interpreted as part of the mathematical calculation.

Common operators for all parameter types

The following operators are available for integer, decimal, and time expressions.

Tab. 2: Common Operators

Operator	Meaning	Example
+	Add	A + 5
-	Subtract	A - 5
*	Multiply	A * 2
/	Divide	A / 2
% or mod	Modulo / remainder	(A + 2) * 3
//	Floor division	7 // 2
<>	Not equal to	A <> 5
>	Greater than	A > 5
<	Less than	A < 5
>=	Greater than or equal to	A >= 5
<=	Less than or equal to	A <= 5
and	Logical AND	(A > 0) and (B > 0)
or	Logical OR	(A > 0) or (B > 0)
xor	Logical XOR	(A > 0) xor (B > 0)

Operator	Meaning	Example
not	Logical NOT	not(A > 0)

Logical comparisons (e.g. and, or) evaluate numerically to either 0 (false) or 1 (true) so they can be used as part of numerical calculations.

Common functions for all parameter types

The following functions are available for integer, decimal, and time expressions.

Tab. 3: Basic utility functions

Function	Description	Example
min(value1, value2)	Returns the smaller value	min(A, 10)
max(value1, value2)	Returns the larger value	max(A, 10)
clamp(value, minimum, maximum)	Restricts a value to a range	clamp(A, 0, 100)
lerp(startValue, end-Value, factor)	Linear interpolation between two values	lerp(10, 20, 0.5)
round(value[, digits])	Rounds a value	round(3.6)
trunc(value)	Removes the fractional part	trunc(3.9)
sign(value)	Returns -1, 0, or 1	sign(A)
pow(baseValue, exponent)	Raises a value to a power	pow(2, 3)
abs(value)	Absolute value	abs(-5)
pos(value)	Returns the greater of the value and 0	pos(-3)
ceil(value)	Rounds up to the next integer	ceil(3.1)
floor(value)	Rounds down to the previous integer	floor(3.9)
sqrt(value)	Square root	sqrt(25)
cbrt(value)	Cube root	cbrt(27)
exp(exponent)	Calculates e raised to the exponent	exp(1)
ln(value)	Natural logarithm	ln(10)
log(value)	Base-10 logarithm	log(100)

Function	Description	Example
<code>if(condition, valueIfTrue, valueIfFalse)</code>	Returns <code>valueIfTrue</code> if condition is non-zero, otherwise returns <code>valueIfFalse</code>	<code>if(A > 0, A, 0)</code>

Tab. 4: Additional trigonometric functions

Function	Description	Example
<code>rad(angleDegrees)</code>	Converts degrees to radians	<code>rad(180)</code>
<code>deg(angleRadians)</code>	Converts radians to degrees	<code>deg(pi)</code>
<code>sin(angleRadians)</code>	Sine	<code>sin(rad(90))</code>
<code>cos(angleRadians)</code>	Cosine	<code>cos(rad(60))</code>
<code>tan(angleRadians)</code>	Tangent	<code>tan(rad(45))</code>
<code>sec(angleRadians)</code>	Secant	<code>sec(rad(60))</code>
<code>csc(angleRadians)</code>	Cosecant	<code>csc(rad(30))</code>
<code>cot(angleRadians)</code>	Cotangent	<code>cot(rad(45))</code>
<code>sinh(value)</code>	Hyperbolic sine	<code>sinh(1)</code>
<code>cosh(value)</code>	Hyperbolic cosine	<code>cosh(1)</code>
<code>tanh(value)</code>	Hyperbolic tangent	<code>tanh(1)</code>
<code>sech(value)</code>	Hyperbolic secant	<code>sech(1)</code>
<code>csch(value)</code>	Hyperbolic cosecant	<code>csch(1)</code>
<code>coth(value)</code>	Hyperbolic cotangent	<code>coth(1)</code>

Tab. 5: Inverse trigonometric functions

Function	Description	Example
<code>asin(value) / arcsin(value)</code>	Arcsine in radians	<code>asin(0.5)</code>
<code>acos(value) / arccos(value)</code>	Arccosine in radians	<code>acos(0.5)</code>
<code>atan(value) / arctan(value)</code>	Arctangent in radians	<code>atan(1)</code>
<code>asec(value) / arcsec(value)</code>	Arcsecant in radians	<code>asec(2)</code>

Function	Description	Example
acsc(value) / arccsc(value)	Arccosecant in radians	acsc(2)
acot(value) / arcot(value)	Arccotangent in radians	acot(1)
asinh(value) / arsinh(value)	Inverse hyperbolic sine	asinh(1)
acosh(value)	Inverse hyperbolic cosine	acosh(2)
atanh(value) / artanh(value)	Inverse hyperbolic tangent	atanh(0.5)
asech(value) / arsech(value)	Inverse hyperbolic secant	asech(0.5)
acsch(value) / arcsch(value)	Inverse hyperbolic cosecant	acsch(2)
acoth(value) / arcoth(value)	Inverse hyperbolic cotangent	acoth(2)

Integer parameter expressions

Integer parameters support the common operators and common functions listed above.

Integer input rules

- Enter whole numbers only when using numeric literals.
- Decimal literals such as 1.5 are not valid for integer expressions.
- If the expression may evaluate to a non-integer value, the expression should be wrapped in a rounding function such as round(), ceil(), or floor() to ensure the result is an integer, otherwise the evaluation may fail during method execution.

Examples:

- Cycles + 1
- max(Replicates, 1)
- pow(2, 3) + 4

Decimal parameter expressions

Decimal parameters support the common operators and common functions listed above.

Decimal input rules

- Decimal literals are supported.
- Use a period (.) as the decimal separator.

Examples:

- 1.5 + 2.25

- {Target Volume} * 0.8
- clamp(5.5, 1.0, 4.25)

Time parameter expressions

Time parameters support the common operators and common functions listed above, plus time-specific functions and time literals.

Simple numerical values in the expression are interpreted as seconds, but they can also be entered in a more convenient time-oriented form with the additional helper functions.

Tab. 6: Time-specific functions

Function	Description	Example
seconds(value)	Interprets the value as seconds	seconds(30)
minutes(value)	Converts minutes to seconds	minutes(5)
hours(value)	Converts hours to seconds	hours(2)
days(value)	Converts days to seconds	days(1)
time(seconds)	Builds a duration from seconds	time(45)
time(minutes, seconds)	Builds a duration from minutes and seconds	time(1, 30)
time(hours, minutes, seconds)	Builds a duration from hours, minutes, and seconds	time(1, 30, 15)
time(days, hours, minutes, seconds)	Builds a duration from days, hours, minutes, and seconds	time(1, 2, 3, 4)

Examples:

- hours(1) + minutes(30)
- time(1, 30)
- max(hours(1), minutes(30))
- {Incubation Time} + minutes(15)

Time literals

Time expressions also support colon-based time literals.

Supported formats:

- mm:ss
- hh:mm:ss

- dd:hh:mm:ss

Examples:

- 1:30 for 1 minute 30 seconds
- 1:30:15 for 1 hour 30 minutes 15 seconds
- 1:02:03:04 for 1 day 2 hours 3 minutes 4 seconds

It is also possible to combine time literals with operators and parameter references.

Examples:

- 1:30 + 15
- {Incubation Time} + 0:30
- 1:00:00 + minutes(15)

Note: If a parameter name itself contains colons, reference it with curly braces so it is treated as a parameter name and not as a time literal.

Example:

- {1:30}

Mathematical constants

The expression engine also supports the following mathematical constants:

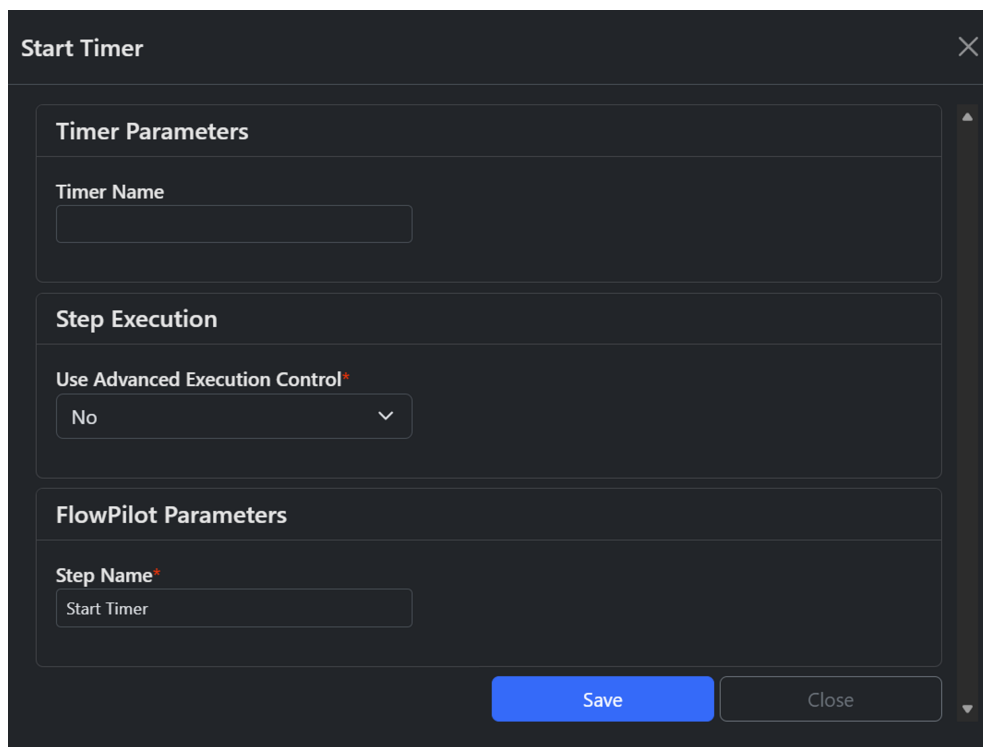
- pi
- e

Note that these are reserved keywords and should not be used as parameter names. Otherwise, the parameter will override the constant and may lead to unexpected results.

3.3.17 Timer Step

The Timer Step allows method step execution to be deferred until a specified time has been reached. The “Start Timer” and “Wait for Timer” steps are used to defer execution; most method steps will also include a “Wait for Timer” parameter that can be used in place of the “Wait for Timer” step. When used, each iteration will have a single, independent timer.

- **Timer Name:** This must be a unique identifier and a Start Timer must be used to create that timer before waiting for that timer with a Wait for Timer step. The Default Timer is started at the start of the iteration. Device “Wait for Timer” delays are associated with that step and start their time when the step is scheduled.
- **Start Timer Step:** Starts the iteration timer. If the timer has already started, it will reset the time to 0. This step is optional.
- **Wait for Timer Step/Parameter:** Delay starting the step by the specified time from the Start Timer Step. If no Start Timer step was used, the timer will be automatically started at the completion of all parent steps. If multiple Wait for Timer step/parameters are used in the method, the specified times must be referenced from last Start Timer step used, not from the last Wait for Timer step or the Start Timer step should be used.
- If the assay is paused or the scheduler is suspended, the iteration timer will also be suspended, and the paused time will not be considered.



Start Timer

Timer Parameters

Timer Name

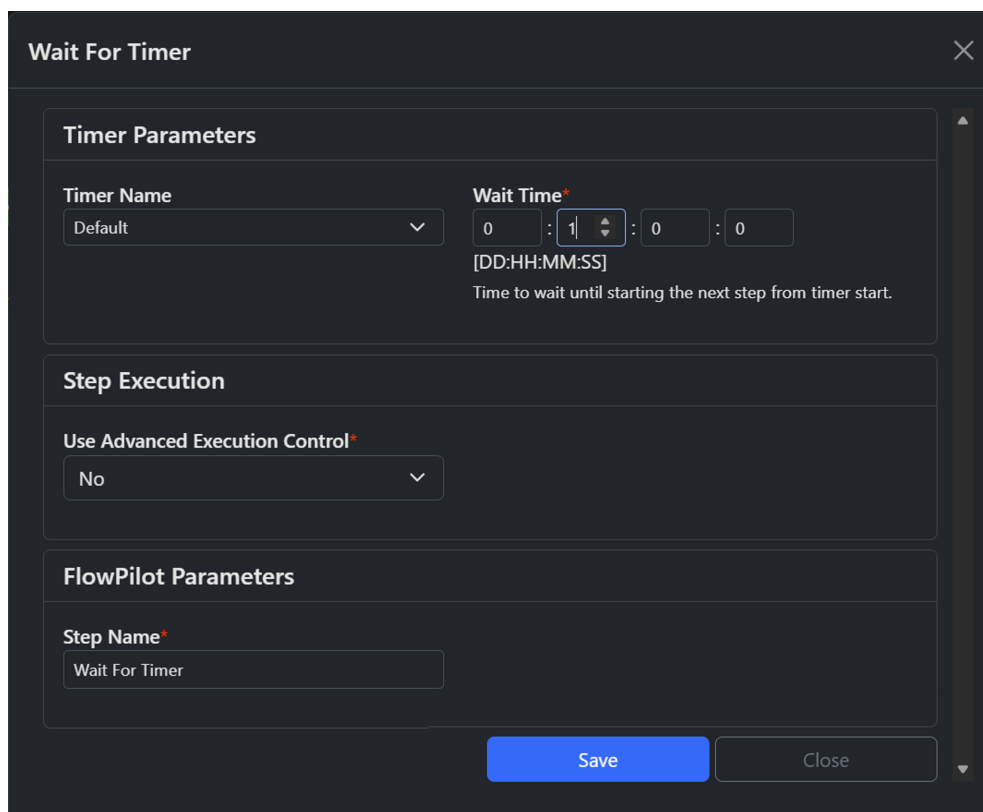
Step Execution

Use Advanced Execution Control*

FlowPilot Parameters

Step Name*

Fig. 26: Start Timer Step



Wait For Timer

Timer Parameters

Timer Name

Wait Time*
 : : :
 [DD:HH:MM:SS]
 Time to wait until starting the next step from timer start.

Step Execution

Use Advanced Execution Control*

FlowPilot Parameters

Step Name*

Fig. 27: Wait For Timer Step

3.3.18 Upstack Step

If the system has stackers configured, the Upstack Step will be available in the available method steps. The upstack step will remove a plate from the system and end in the specified stacker group. The upstack step must be the last valid use of the plate in the method, otherwise the method cannot be saved. Once the plate is upstacked, it is removed from system inventory and cannot be further used in the system unless re-introduced.

Fig. 28: Upstack Step

3.4 Method Configuration

The Method Editor provides a diagram-based interface for creating and editing methods. A method consists of a series of steps that are executed during a single assay iteration. During a run, each assigned plate proceeds through the defined steps in the sequence shown. The user may edit the method in the following ways:

- **Add a new step:** To add a new step, click the desired step to add, fill out all fields and click save. The step will be added to the last available step in the method.
- **Add child step:** To add a new step as a child to a specific step(s), select the desired parent step(s), add the new step as above, and the new step will be added as a child to all selected steps.
- **Insert a new step:** To insert a step between two (or more) existing steps, select the desired connector(s) and add a new step as above. The step will be inserted between the parent and child steps that the connector linked together.
- **Connect two steps:** To connect two steps that are not connected, drag from the output port (bottom/right) of the parent step to the input port (top/left) of the child step.
- **Remove a step or connector:** Select the step/connector and click the Delete key.

- **Duplicate step(s):** To duplicate a step or series of steps, either individually select the step(s) and connectors (hold Ctrl when clicking) or drag a selection box around the desired steps. Once selected, click Ctrl-C to copy and Ctrl-V to paste. You will need to draw a new connector to link the duplicated steps to the appropriate parent step.
- **Undo/Redo an action:** If you are not satisfied with an action and wish to undo, click Ctrl-Z and the action will be undone. To re-apply an action that was undone, click Ctrl-Y and the action will be re-applied.
- **Swap the order of two steps:** Hold the Ctrl key and select the two steps to be swapped. Press the blue swap button located in the top right corner of the Method Editor.
- **Pan & Zoom:** Drag on empty canvas part to pan. Use the mouse scroll wheel to zoom in/out. Double click the canvas to zoom incrementally.
- **Edit Step:** Double click the desired step, adjust parameters, and click save.
- **Fit to Page:** Click "Fit to Page" or hold down the Ctrl key and double click the canvas.
- **Auto Layout:** Click "Auto Layout" or hold down the Shift key and double click the canvas.

To save the method file, the user must click the "Save Method" button. If the user navigates away from the Method Editor without saving, the system will prompt the user that there are unsaved changes to prevent unnecessary loss.

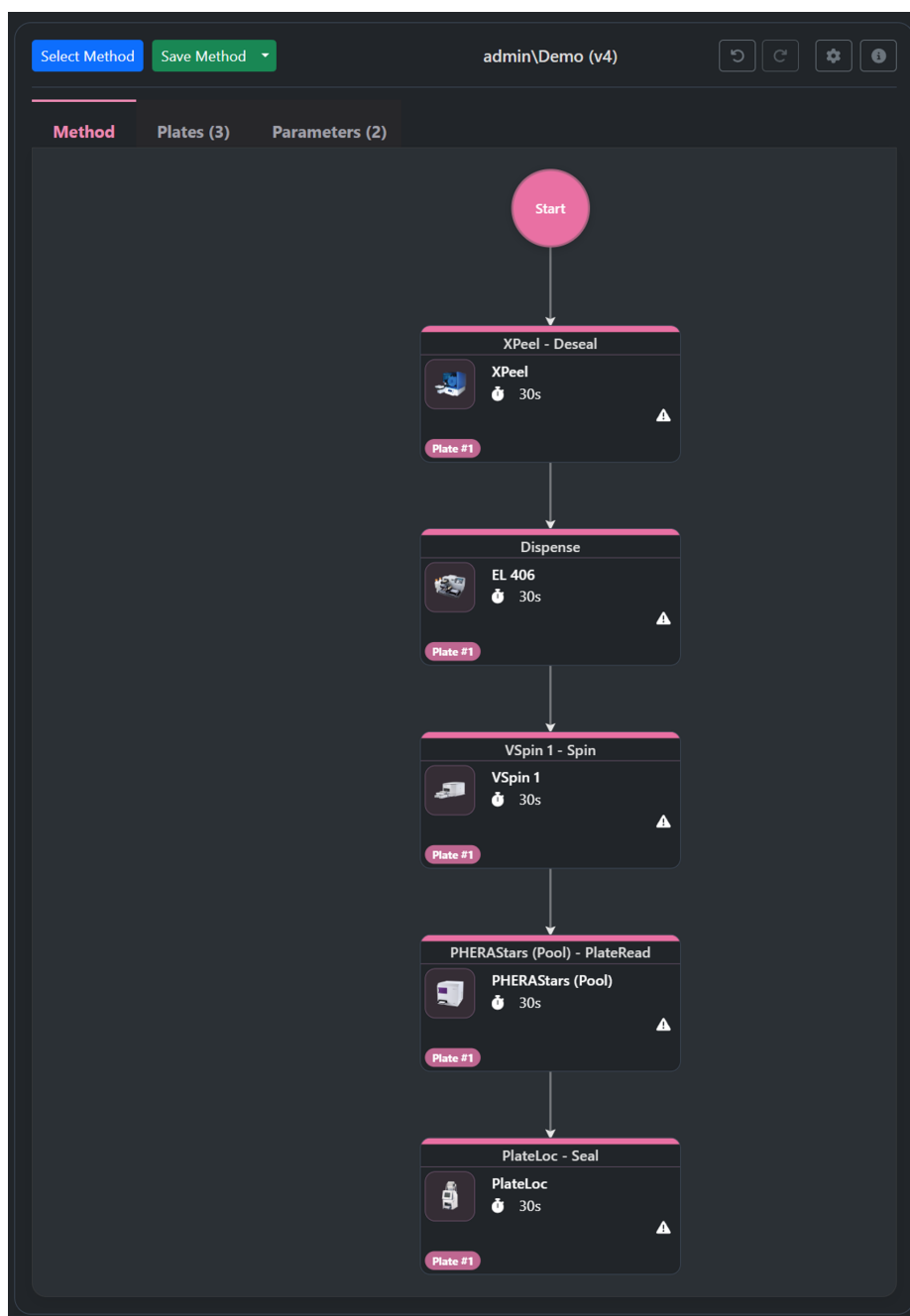


Fig. 29: Example Method

3.4.1 Plate Configuration

For each method, the user must specify the plates that will be used to complete one iteration of the method. By default, a single plate is configured, and the user may remove all plates or add as many plates as required.

To configure the plates on the method, the user must select the Plates tab and add/remove plates as needed.

Plate #	Label	Default Plate Type	Default Distribution Type
1	Plate #1	--Optional: Default Plate Group--	--Optional: Default Plate Type--
2	Plate #2	--Optional: Default Plate Group--	--Optional: Default Plate Type--
3	Plate #3	--Optional: Default Plate Group--	--Optional: Default Plate Type--

Fig. 30: Plate Configuration

Custom labels may be given to each plate to help the operator understand how each plate will be used in the method. Optionally, the user may specify the default plate type/group and distribution type for each plate; these options are generally used when the values will always be the same for all runs, which removes the need for the operator to select the values when scheduling the run.

3.4.2 Method Parameters

Method Parameter feature has been added that allows the user to configure unique parameters for each method. When an assay is run, the parameters will be unique to each assay and will not be able to be accessed outside of the assay.

To set up parameters in a method, click on the Parameters tab. Each parameter will have the following fields that must be set:

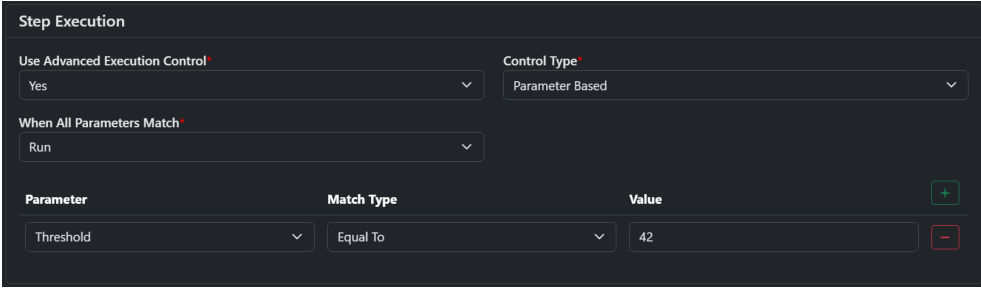
- **Parameter Name:** Enter a unique parameter name.
- **Description:** Description of the parameter.
- **Type:** The data type of the parameter.
 - **String**
 - **Integer:** A whole number.
 - **Decimal:** A decimal number.
 - **Boolean:** True/False.
 - **Time**
- **Starting Value:** The initial value of the parameter at the start of an assay run.
- **Parameter Scope:**
 - **Iteration:** An independent parameter is maintained for each assay iteration.
 - **Assay:** One instance of the parameter maintained for each scheduled run.
 - **Global:** A global parameter (refer to “Global Parameters” [108]).
- **Set Value on Run Start:** Select Yes if the operator should be able to update the value on the Schedule Run screen when starting an assay. Only applicable to Assay scoped parameters.
- **Constant:** Prevents the parameter from being modified (only available for assay and global scoped parameters).
- **Rule Set:** Allows entering a minimum and/or maximum acceptable value for a number/time based parameter.

Parameter Name	Description	Type	Starting Value	Parameter Scope	Set Value on Run Start	Rule Set
Protocol Name		String	Protocol1	Assay	Yes	
Threshold		Integer	42	Assay	Yes	Minimum Maximum

Fig. 31: Method Parameters

After parameters have been created in the method, they can be utilized in the following ways:

- Used as the value for a step parameter.
- Used within the Step Execution to determine if a step should run.



Step Execution

Use Advanced Execution Control^{*} Yes Control Type^{*} Parameter Based

When All Parameters Match^{*} Run

Parameter	Match Type	Value
Threshold	Equal To	42

Fig. 32: Step Execution

- Read/Updated within a script step.
- Set Parameter step.
- Prompt step.
- Receive updated value from a driver.

When an assay is running and the method has parameters, a Parameters tab will be displayed in the assay that will show the current values of any parameters in the assay when the tab is loaded; to update values, click the refresh button. If a user has the applicable permission (Update Parameters During Run), then the user will be able to update the parameter value during the run.

3.4.3 Step Parameters

Each Method Step has specific parameters that can be configured for different step behavior. In general, there are four sets of parameters: Device Parameters, Step Execution, Loading Pattern and FlowPilot Parameters. After setting the desired configuration, the Save button is clicked (note: this does not save the method file, the method file save button must still be clicked). The Close button will discard any changes made.

Fig. 33: Method Step Parameters

3.4.3.1 Device Parameters

All steps will have unique parameters that will be collected and sent to the driver that control how the device will operate when executing the step in the assay. All devices are configured with a standard set of parameters, but these can be configured as needed on a per-instance basis in the FlowPilot Configuration Support.

3.4.3.2 FlowPilot Parameters

Most steps share a common set of general parameters as follows:

- **Step Name:** Custom label displayed on the method step within the Method Editor.
- **Priority:** Relative priority of the Method Step compared to the same Method Step used multiple times within the method. For example, when a Deseal step on Device A is used twice within the same method, and 2 plates need to use

the Desealer during the run, the step with the higher priority will be prioritized first. If the priority is not adjusted, then whichever plate requests use of the device will be processed first.

- **Simulation Times:** Used when simulating a run to develop an estimated run time.
 - **Load:** The average estimated time to load one plate from the storage device to the instrument.
 - **Operation:** The estimated time for primary instrument operation to complete.
 - **Unload:** The estimated time to unload a plate from the instrument to storage device.
- **Barcode Verification:** Directs the robot to scan the barcode of the plate(s) when moving to/from the device and take the action selected:
 - **Read:** Read the barcode and log into the general FlowPilot log.
 - **Update:** Read the barcode and update the inventory if it does not match.
 - **Validate In:** Read the barcode when moving the plate into the device and validate it matches the expected barcode from inventory. If not, prompts the operator for recovery action.
 - **Validate Out:** Read the barcode when moving the plate out of the device and validate it matches the expected barcode from inventory. If not, prompts the operator for recovery action.
 - **Validate Both:** Read the barcode when moving the plate into and out of the device and validate it matches the expected barcode from inventory. If not, prompts the operator for recovery action.
- **After Step Complete:** Indicates what should happen to the primary nest plate at the end of a step. Only applies if not the last step in the method.
 - **Return plate to home location:** Plate will be moved to home location after step completion (default process).
 - **Leave assay plate at current location:** Plate will be left at the station after step complete, then plate will be moved directly to the next station.
- **Wait for Timer:** Delay starting this step by the specified time from the completion of all previous parent steps.

3.4.3.3 Loading Pattern

Most method steps have the capability to specify the plate loading pattern. For each nest, the user will specify the plate(s) that will be delivered to the device during the execution of the step. All devices will have at least one nest which is considered the primary nest for the device. The name of the nest is defined in the Device Configuration in the System Layout.

The user must specify at least one plate that was configured in the Method plates section to be moved to the primary nest. The "Use Selected Plate(s)" question allows the user to specify when the step should be executed for the selected plate(s). If multiple plates are selected for the primary location, the complete step actions will be completed for each selected plate, and the step will be considered "completed" when all selected plates have been processed.

Fig. 34: Loading Pattern

All other nests can optionally be loaded using the following options:

Loading Pattern

- **Do Not Load:** Do not load a plate into this nest.
- **Load Single Plate:** Load one plate onto the nest.
- **Load Single Plate and Dispose:** Only available if the device is configured in the system layout to allow disposal of plates on the device. Instead of unloading the plate, the system will treat the plate as disposed on the device and be deleted from inventory; it is the responsibility of the device protocol to ensure the plate is disposed during the execution of the protocol.
- **Load Selected Plate(s):** Sequentially load the selected plate(s), running the main operation on the device for each plate before unloading.
- **Load All Remaining Plates:** Sequentially load all plates that have not been used in other nests in this step, running the main operation for each plate before unloading.

Leave At Station

- **No:** Plate is moved back to its home location.
- **Yes:** Leave the plate at current nest after the operation has been completed. Leaving the plate is an advanced operation and should only be left by experienced operators; deadlocks or plate move conflicts are possible when leaving the plate, especially when multiple assays are run. The method editor will attempt to detect conditions that will lead to a deadlock and prevent the method from being saved until corrected. The plate will stay only if the following conditions are met:
 - The plate is not used on any other device or nest in the iteration before being used at the initial device and nest.
 - If the plate is left on the last use of the device in an iteration, the next iteration must use the same plate on the first use of the device.

If a device has more than two nests, all nests will be loaded as configured, the device operation will run, and plates will be unloaded.

3.4.3.4 Step Execution

The Step Execution section allows the user to specify if the step should run/not run on the current iteration. There are two methods of using Advanced Execution Control: Parameter or Iteration based. Parameter based allows the user to specify a set of parameters that must be met for the step to be run/not run. Additionally, a

set of I/O monitors can also be specified if any monitors are defined in the I/O Configuration. Iteration based allows the user to selectively run the step based on the iteration that is currently executing.

The screenshot shows the 'Step Execution' dialog box with the 'Control Type' set to 'Parameter Based'. The 'Use Advanced Execution Control' is set to 'Yes'. The 'When All Parameters Match' is set to 'Run'. Below this, there is a table with three columns: 'Parameter', 'Match Type', and 'Value'. The first row shows 'Threshold' as the parameter, 'Equal To' as the match type, and '42' as the value. There are '+' and '-' buttons to the right of the table to add or remove rows.

Fig. 35: Step Execution Parameter Based

The screenshot shows the 'Step Execution' dialog box with the 'Control Type' set to 'Iteration Based'. The 'Use Advanced Execution Control' is set to 'Yes'. The 'Step Execution Method' is set to 'For All Iterations'. The 'On the First/Last Iteration' is set to 'Run'. The 'Always Run on Last Iteration of Assay' is set to 'Yes'. There are also fields for 'Run on Every X Iterations' and 'Do Not Run on Every X Iterations', and 'Run These Iterations' and 'Do Not Run These Iterations'.

Fig. 36: Step Execution Iteration Based

3.4.3.5 Pooled Device Step

If a device was configured to enable pooling in the System Layout, there will be a single method step available for the pool group instead of a method step per device. When selecting a pooled method step, the user will need to decide which of the devices in the pool may be used for the execution of the step during the run. Additionally, if the method will use a device multiple times, the method may be configured to always send the plate back to the same device within the same iteration (e.g., ensuring a plate that is read multiple times is always read on the same reader).

The screenshot shows the 'Device Selection' dialog box. The 'Pooled Devices To Use' section shows two devices: 'Pherastar 1' and 'Pherastar 2'. The 'Use Same Device' section has a 'Yes' radio button selected and a 'No' radio button. Below this, there is a note: 'If the device is used more than once in the iteration, use the same device used in the last pooled step'.

Fig. 37: Device Pooled Selection

3.5 Complex Methods

FlowPilot supports the ability to create methods with multiple parallel branches. This allows the user to design complex assays that otherwise might require multiple methods.

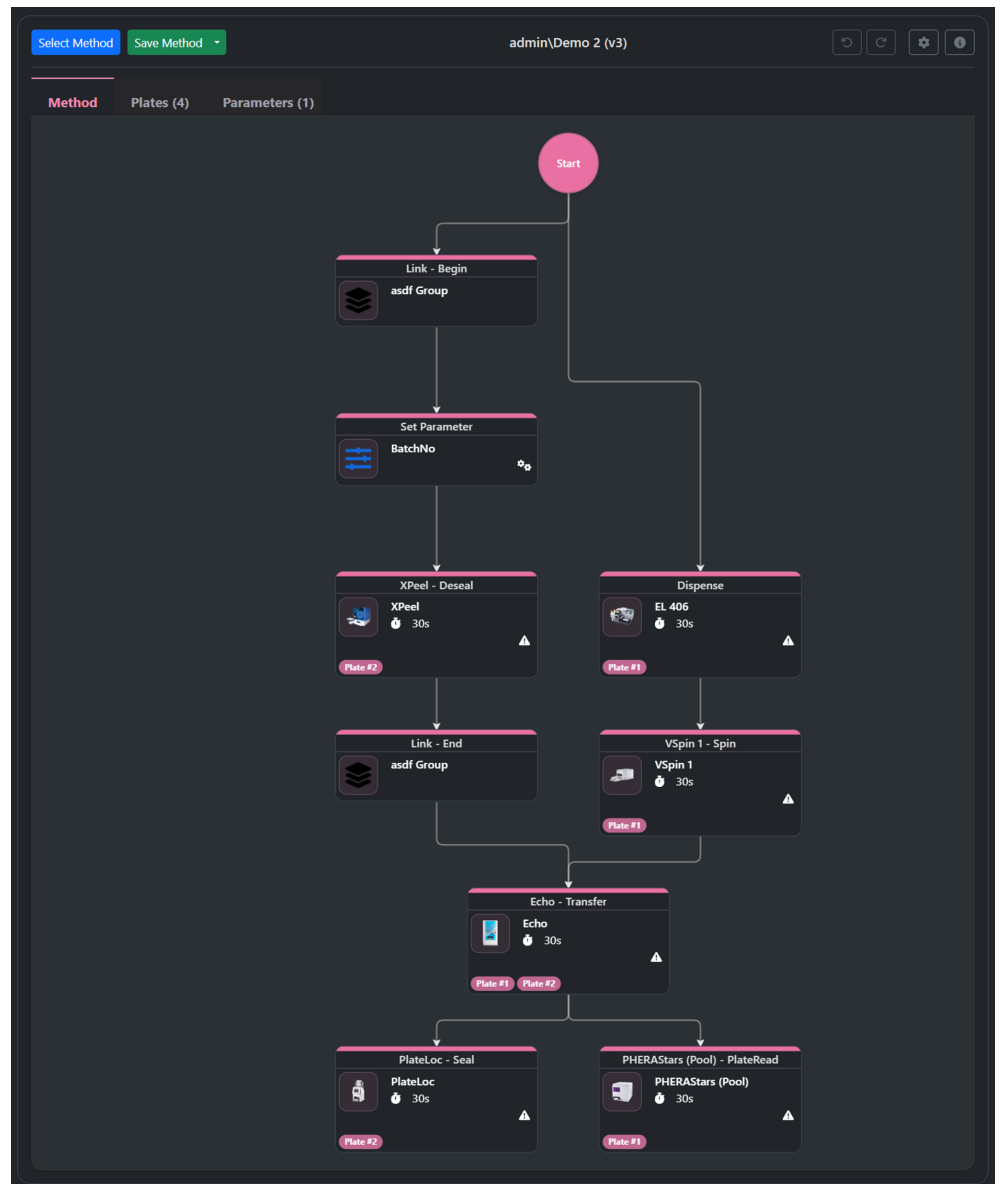


Fig. 38: Complex Method Example

3.6 Method Change Tracking

Method file changes will be tracked when the method is saved, and previous versions can be viewed or edited to create a new version. To access the method file history, the user will click on the file name at the top of the method currently being viewed, and a file history dialog will be displayed. All previous versions will be listed with links to view or edit. Method file tracking may be disabled in settings for FlowPilot.

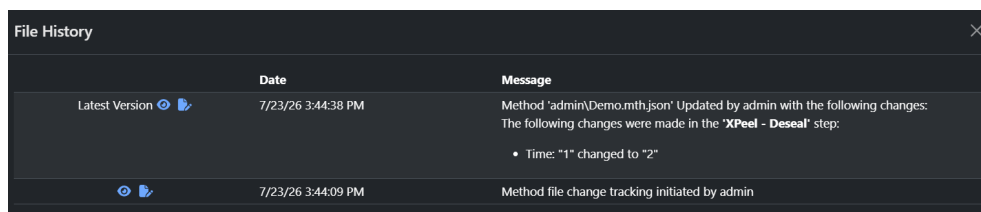


Fig. 39: File History Dialog

3.7 Security

The following role permissions are available to control access to the Method Editor:

- **Create & Update Methods:** Allows the user to create a new method or update an existing method.
- **Edit all Users Methods:** Allows the user to modify any user's method file. If the user loads a method file owned by a different user, changes will be saved to a copy of the method that exists in the user's folder.
- **Can Create & Use Other Method Root Folders:** Allows the user to create folders outside of their user folder.

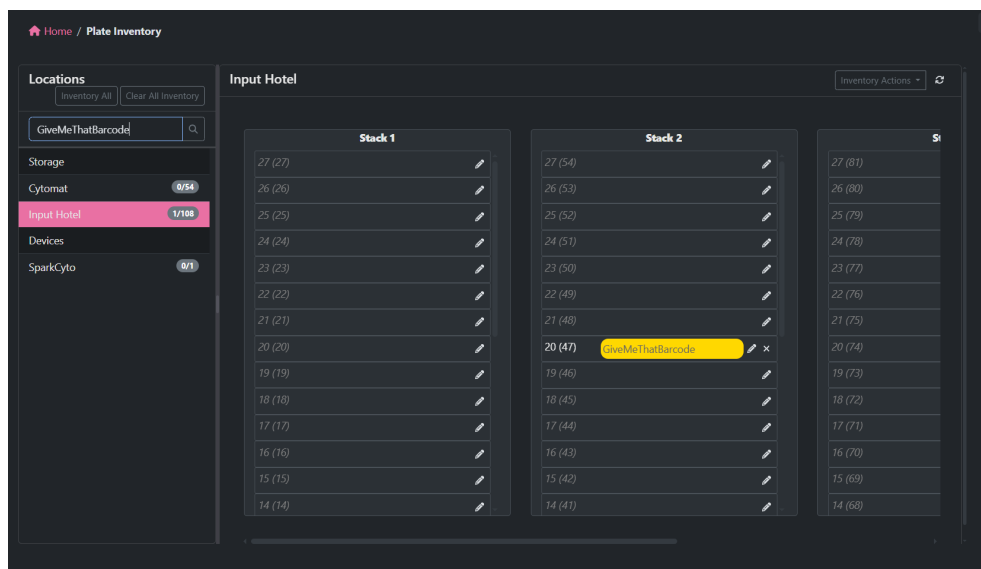


Fig. 41: Storage Selection

4.1.2 Edit Individual Barcodes

A user with appropriate security permissions may manually add, update, or delete an individual barcode. To add or update a barcode, click the edit icon (pencil) at the desired location and enter the new barcode in the input displayed. To delete an existing barcode, click the delete icon (x) at the desired location. Note that any barcode that is updated or deleted that is not at the home location (barcode will have the @ symbol appended to the end of the barcode at the home location) will be updated/deleted at both the current and home location.

On occasions, a barcode may have a cache location assigned, indicated by the \$ icon (cache icon) appended to the end of the barcode. To clear the cache location, click the cache icon. This is generally only necessary if the user created a method that cached a plate and either did not clear the cache as part of the method or aborted the iteration mid-assay.

4.1.3 Inventory Location(s)

Users with appropriate security permissions may start a robotic inventory of the selected storage location. Click the "Inventory Location(s)" button in the storage header to start the process. The user will select the desired cells in the storage device to inventory and click the Run Inventory button. A special inventory run will be added to the queue and will be executed based on robot availability.

4.1.4 Inventory and Clear All Locations

Users with appropriate security permissions may start a robotic inventory of all available storage locations using the "Inventory All" button in the storage locations header. The user will select the plate type and inventory mode to be used before confirming the operation. Similarly, users with appropriate security permissions may clear all inventory locations using the "Clear All Inventory" button in the storage locations header.

4.1.5 Bulk Deletion of Barcodes

Users with appropriate security permissions may bulk delete plates in storage devices. Click the dropdown on the “Inventory Location(s)” button in the storage header to start the process. The user will select the desired cells in the storage device to delete from inventory and click the Delete button. Barcodes will immediately be deleted from inventory.

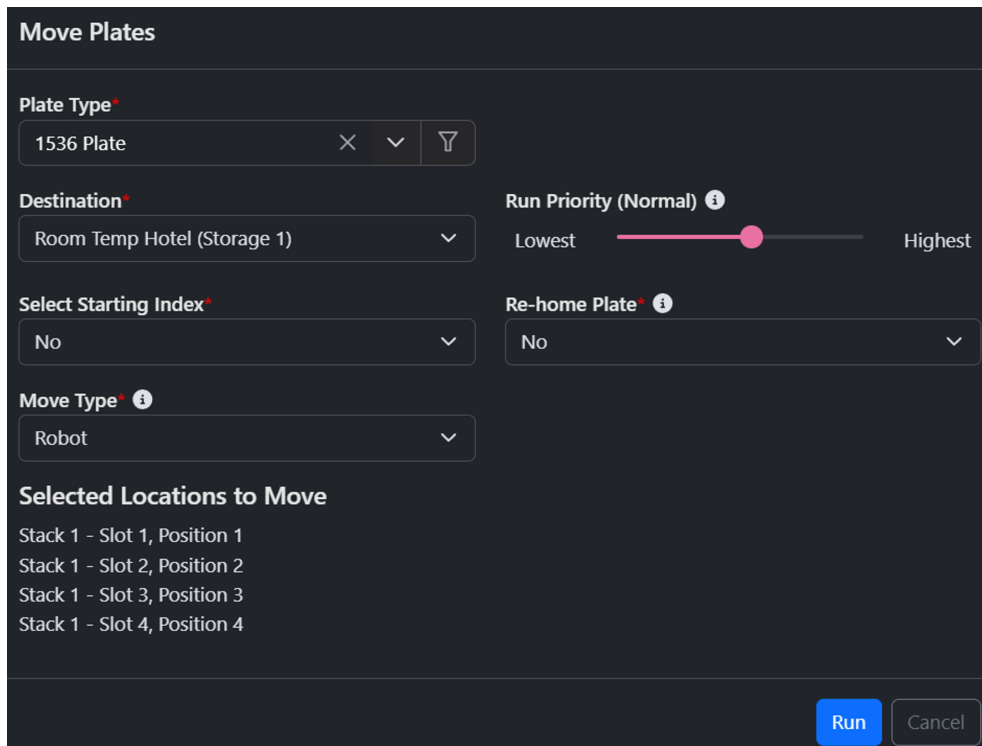
4.1.6 Move Plates

Users with appropriate security permissions can move plates in the inventory control editor via two methods: move plate home and move plates to location. If the plate is being removed from a device that has a nest that changes position, the move should properly present the nest for the move.

If a plate is not in its home location, the move home icon (house) will appear next to the barcode. When a user clicks the move to home location button, a move plate run will be queued and executed based on robot availability.

To move plates to a new storage location, click the Move Plate(s) button in the storage header. The user will select the following:

- **Plate Type:** Plate Type of selected plates. All plates selected must have the same plate type. This selection directs the robot how to grip the plate.
- **Lid Type:** Lid Type of selected plates. All plates selected must have the same lid type. This selection is used by the robot to determine if lidding is required.
- **Destination:** Receiving location for the plate.
- **Priority:** Priority of the move plate operation versus running assays.
- **Starting Index:** If the Destination is a storage location, the user may select the starting index of the destination storage location.
- **Rehome Plate:** If the Destination is a storage location, the user may opt to permanently rehome the plate. Otherwise, the move is treated as a temporary move.
- **Move Type:** Indicates if the plate is manually being moved by the operator, or if the robot is moving the plate.
- **Barcode(s):** Barcode(s) to move. The user may not select more barcodes than storage available in the receiving location.



Move Plates

Plate Type*
1536 Plate [X] [v] [Filter]

Destination*
Room Temp Hotel (Storage 1) [v]

Run Priority (Normal) i
Lowest [Slider] Highest

Select Starting Index*
No [v]

Re-home Plate* i
No [v]

Move Type* i
Robot [v]

Selected Locations to Move
Stack 1 - Slot 1, Position 1
Stack 1 - Slot 2, Position 2
Stack 1 - Slot 3, Position 3
Stack 1 - Slot 4, Position 4

Run **Cancel**

Fig. 42: Move Plate(s)

4.1.7 Assign Allowable Plate Types

Users with appropriate security permissions may specify that selected inventory locations are restricted to certain plate types. If no plate type(s) are assigned to an inventory location, then it is assumed that all plate types are allowed. When starting a run, inventorying a location, or moving plates to specified location, the selected plate type will be verified against the allowed plate types. If a plate is moved or cached to a location as part of a method, only allowable locations based on plate type will be utilized; if no locations are available when needed, the system will alert the operator, and the operator will need to take action to ensure there is allowable space available in the storage device in order to proceed.

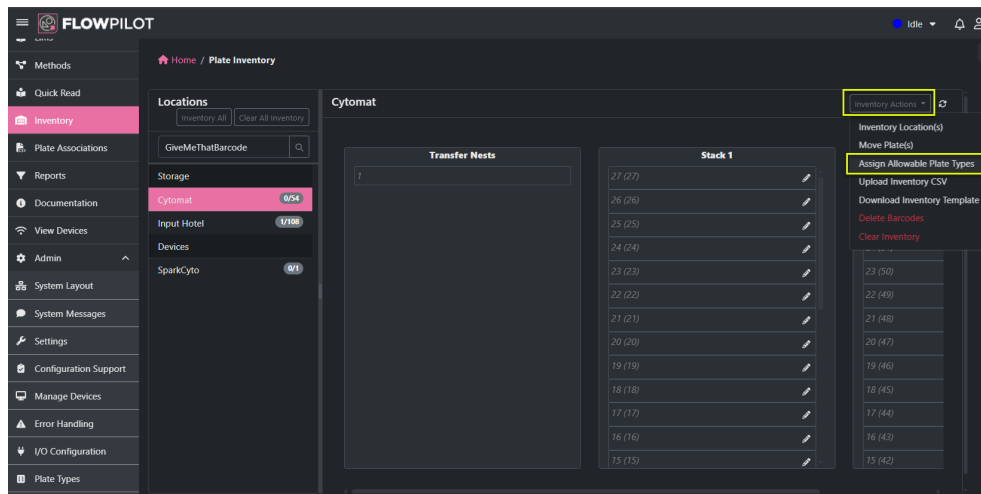


Fig. 43: Assign Allowable Plate Types

4.1.8 Upload Bulk Inventory

Users with appropriate security permissions may upload the inventory of a storage device via spreadsheet. The user should first download the inventory template by clicking the dropdown on the “Upload Inventory” button and selecting “Download Inventory Template”. In the csv template, the user may add/update/remove barcodes as required to accurately reflect the current state of the inventory. The template file may be dropped on the Upload Inventory button or selected via file explorer when the button is clicked. Once the file has been uploaded the contents of the file will be displayed for final confirmation. The user can select which device index locations should be updated (all will be selected by default). After clicking the Update button, the inventory for the selected storage device will be updated immediately.

Inventory Update		
Please verify the records to update.		
	Index	Barcode
☒	1	#260528051715702
☒	2	O105836286258808
☒	3	
☒	4	
☒	5	
☒	6	
☒	7	
☒	8	
☒	9	
☒	10	
☒	11	
☒	12	
☒	13	
☒	14	
☒	15	
☒	16	#260528051715665

Fig. 44: Bulk Inventory Upload

4.2 Print & Apply Barcodes

If a Barcode Labeler device is configured on the System Layout, a Print & Apply Barcodes option will be available under the Inventory Locations button in the Plate Inventory screen on each storage location. This feature is used to apply barcodes and/or data labels to plates as a separate process. Depending on the barcode labeler integrated, the precise function of the feature will be different based on how it operates.

In general, the user can optionally upload a csv file that contains barcodes and/or data labels. The user can also specify which sides of the plate to apply barcodes/labels, and either specify fixed data or reference a column from the csv file. Additionally, the user will select the plates to run the process on from the inventory panel below.

Starting from the lowest index, FlowPilot will pick the plate, grab the first row in the csv file (if applicable), and send the plate to the barcode labeler. Specified labels/barcodes will be applied, the plate will be inventoried and returned to its original storage position. FlowPilot will then repeat for each plate in ascending index order, using the next row in the csv as applicable.

Print & Apply Selected Locations

Barcode Device*

VCode

Scan Barcode After Print and Apply*

Yes

Plate Type*

--Select Plate Type--

Barcode List

Upload File

North

Label Format

None

East

Label Format

None

South

Label Format

None

West

Label Format

None

Selected Locations to Print & Apply

Stack 1 - Slot 10, Position 10

Stack 1 - Slot 11, Position 11

Stack 1 - Slot 12, Position 12

Stack 1 - Slot 13, Position 13

Select All

Run Print & Apply

Cancel

Fig. 45: Print & Apply

4.3 Plate Association Editor

When running an assay using the Plate Association File, a barcode plate list is required. The Plate Association Editor can be used to create the plate association file. Alternatively, users can create the plate association file using external file editors such as Excel, notepad, etc.

4.3.1 Plate Association File Structure

The Plate Association file is formatted as a Comma Separated Value (csv) text file. Each row in the file defines a single iteration of the method, and the association between plates used.

The Plate Association file must follow certain conventions:

- For each plate configured in the Method Plate Configuration, there must be a column in the Plate Association file. The column order will match the order of the defined plates.
- All Assays will require at least the first column. The first column must specify either (all rows must use the same option):
 - The barcodes of all plates used as the first specified plate in the iteration.
 - The text “AUTO” if the plate will be pulled from a designated storage location (sequentially for each iteration) and inventoried on first use.
- The remaining columns will be associated with the plates defined in the Method Plate Configuration section. Pre-inventoried barcodes are required.
 - If the “Allow Run to Start with Mixed Inventory” setting is set to “No”, the listed barcode is required to be at its home location before the assay may be scheduled.
- Duplicate barcodes may not be listed in the same row (iteration).

4.3.2 File Selection

On initial load of the Plate Association Editor, the user will be prompted to either load an existing file or create a new file. Plate Association files are associated with specific users (viewed as a folder within the file selection) by default. A user may view a Plate Association file located in any folder. When re-saved, a new editable copy of the file will be created under the current user's folder.

To create a new file, the user must select the folder where the file will reside and click “New File”. A window will display, requiring the user to enter a unique file name. The system will append the appropriate file extension.

To create a new folder/sub-folder, the user must select the parent folder and right click. A menu will appear that allows the user to select “New Folder”. A window will display that allows the user to enter a unique folder name.

If the user has elevated security permissions, the user may create new files and folders at any location. Otherwise, the user is limited to creating new files and folders in their user-based folder.

A user may select an existing file to edit by either selecting the file and clicking “Load File”, or by double-clicking on the desired file. A file or folder may be deleted by a user by right clicking on the selected item and selecting the “Delete” option on the menu that appears. If a user does not have elevated security permissions, only files and folders in their user-based folder may be deleted. A loaded file can be copied by selecting the “Save As” option instead of saving the file.

4.3.3 Editor

The csv editor is on the left side of the screen, and the selected storage is now displayed on the right. The user may modify how wide the csv editor is by clicking and dragging the splitter between the editor and storage.

To select barcodes, the user may take the following options:

- Click the “Select All” link in the upper right corner to select all barcodes.
- Click the “Select” link at the top left of a stack to select all barcodes in a stack.
- Click a single barcode.
- Click a barcode, hold SHIFT, and click another barcode; all barcodes between the initial barcode and the second barcode will be selected.
- Click a barcode, hold CTRL, and click one or more barcodes; all barcodes clicked will be selected.

To paste selected barcodes into the csv editor, select the starting cell, and click CTRL+V.

The Plate Association Editor looks and behaves like Excel; users can copy & paste cells (CTRL-C/V or right-clicking), select multiple cells, and navigate using keyboard arrows. Additionally, there are two buttons above the Editor for pasting data:

- **Paste (Vertical):** Selected barcodes will be pasted vertically starting in the selected cell. This is the same action that will occur if the CTRL+V shortcut is used.
- **Paste (Horizontal):** Selected barcodes will be pasted horizontally starting in the selected cell.

Depending on the browser, the user may be prompted by the browser for permission to access the system clipboard; this permission must be granted to use these buttons. Additionally, any data the user has added to their clipboard may be pasted into the Plate Association file.

On saving, the following items will be validated:

- There is 1+ row(s).
- Barcode size is limited to the Maximum Barcode Length setting.
- No rows are skipped.
- No duplicate barcodes in the first column.
- Barcodes in the first column may not be used in another column.

If the user loads a plate list file owned by a different user, changes will be saved to a copy of the method that exists in the user’s folder.

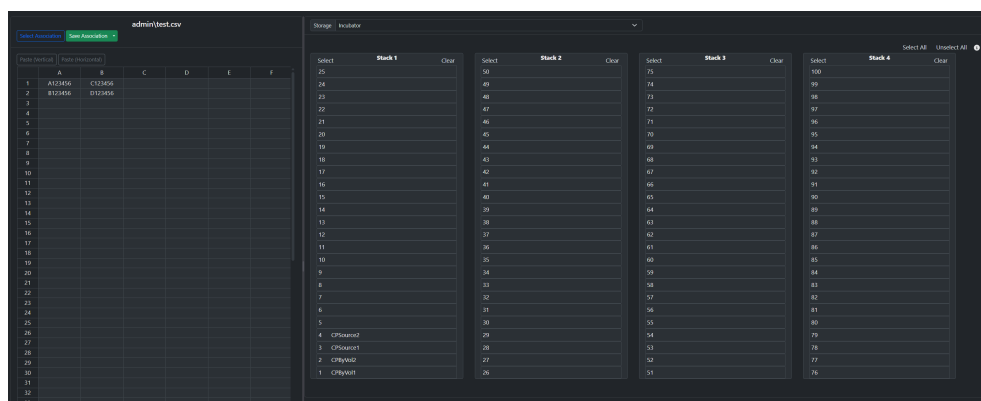
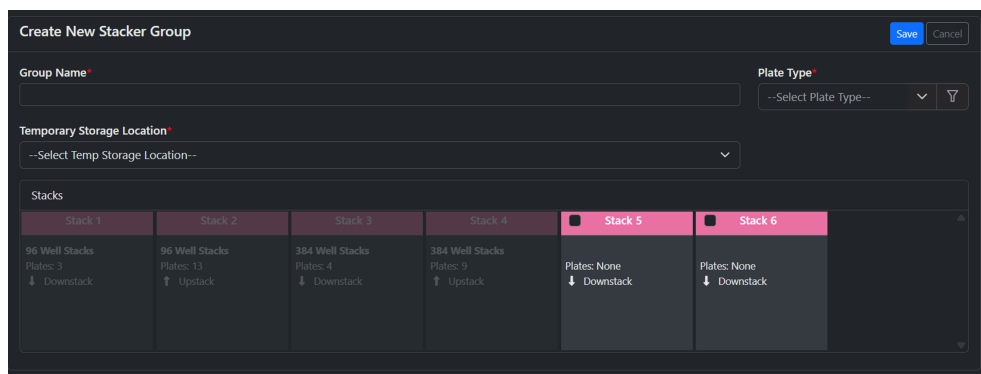


Fig. 46: Plate Association Editor

4.4 Stacker Support

When adding a stacker on the System Layout, for each stack, the operator must enter the height of the stack (in mm), and the maximum number of plates to allow in the stack. FlowPilot will calculate the physical maximum number of plates allowed based on the height of the stack and the height of the plate; the actual maximum number allowed will be the lower number.

After all stacks have been added on the system layout, 'Stacker Groups' must be created on the Plate Inventory to use the stackers. Click on the 'Create Group' button to create a new stacker group. Each stacker group must have at least one stack. In general, a stacker group will have a minimum of 2 stacks, one for downstacking (introducing plates into the system) and one for upstacking (removing plates from the system). Each stacker group must have the Plate Type and Lid Type set (these may be changed later as needed). The Stacker Group Name may not be changed after being created.



Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6
96 Well Stacks Plates: 3 ↓ Downstack	96 Well Stacks Plates: 13 ↑ Upstack	384 Well Stacks Plates: 4 ↓ Downstack	384 Well Stacks Plates: 9 ↑ Upstack	Plates: None ↓ Downstack	Plates: None ↓ Downstack

Fig. 47: Create New Stacker Group

Once stacker groups have been configured, the following actions can be taken on the stacker group page:

- **Manage Group:** Allows the Plate Type or Lid Type of the group to be modified.
- **Count Plates:** Starts a robotic count of plates in the selected stack(s).
- **Downstack Plates:** Rehomes a specified number of plates from the stacker group to a specified storage device.
- **Manually Edit Plate Count:** Manually input the number of plates in a stack.
- **Change Stack Direction:** Toggle the stack from being used as either Downstack or Upstack.

Upstack from plate inventory: When on a standard storage device, a new option has been added to allow plates to be moved from the storage device and up-stacked to a stacker group.

When starting an assay run, stacker groups can be selected as the storage location for any of the plates. When selected, the operator must select a "Temporary Plate Storage" location to be used as the temporary home location of the plate during the assay as the stacker cannot be used. The operator will also select if the plate should be up-stacked back to the stacker after its last use in the assay. If not up-stacked, then the plate will be permanently homed in the selected temporary storage location.

Upstack Step: Additionally, an Upstack step has been added to the method editor (only available when stackers are present) that allows a plate to be up-stacked to a selected stacker as part of the method (location can be deferred to run start). The

Upstack step must be placed after the last use of the plate in the method. This step can be used to remove the plate when the plate starts in standard storage, or the plate needs to be up-stacked to a different stacker group.

4.5 Security

The following role permissions are available to control access to Plate Inventory:

- **Use Plate Association Editor:** Allows user access to the Plate Association Editor feature.
- **Edit all Users Plate Association Files:** Allows the user to modify any user's file.
- **Can Create & Use Other Plate Association Root Folders:** Allows the user to create folders outside of their user folder.
- **Upload Bulk Inventory:** Allows access to the bulk inventory upload feature.
- **Clear All Inventory:** Allows the user to clear all inventory using a button at the top of the plate inventory screen.
- **Inventory Locations:** Allows user to initiate a robotic inventory of a storage device.
- **Move Plates:** Allows the user to move plates between storage locations.
- **Edit Barcodes:** Allows the user to manually edit or delete discrete storage location barcodes.
- **Manage Stacker Groups:** Allows the user to create & update stacker groups.

5 Scheduler

The FlowPilot home page is where runs and simulation runs can be viewed and managed.

5.1 Loaded System Layout

The loaded System Layout is displayed on the right side of the FlowPilot layout. This System Layout view can differ from the one displayed in the System Layout Editor if the scheduler was not restarted after modifications were saved. This view displays a colored network connection icon for each device in the System Layout:

- **Green:** Device Driver is connected.
- **Gray:** Device is in simulation mode.
- **Red:** FlowPilot was unable to connect to the device driver.
- **No Network Icon:** The device does not have an associated driver.

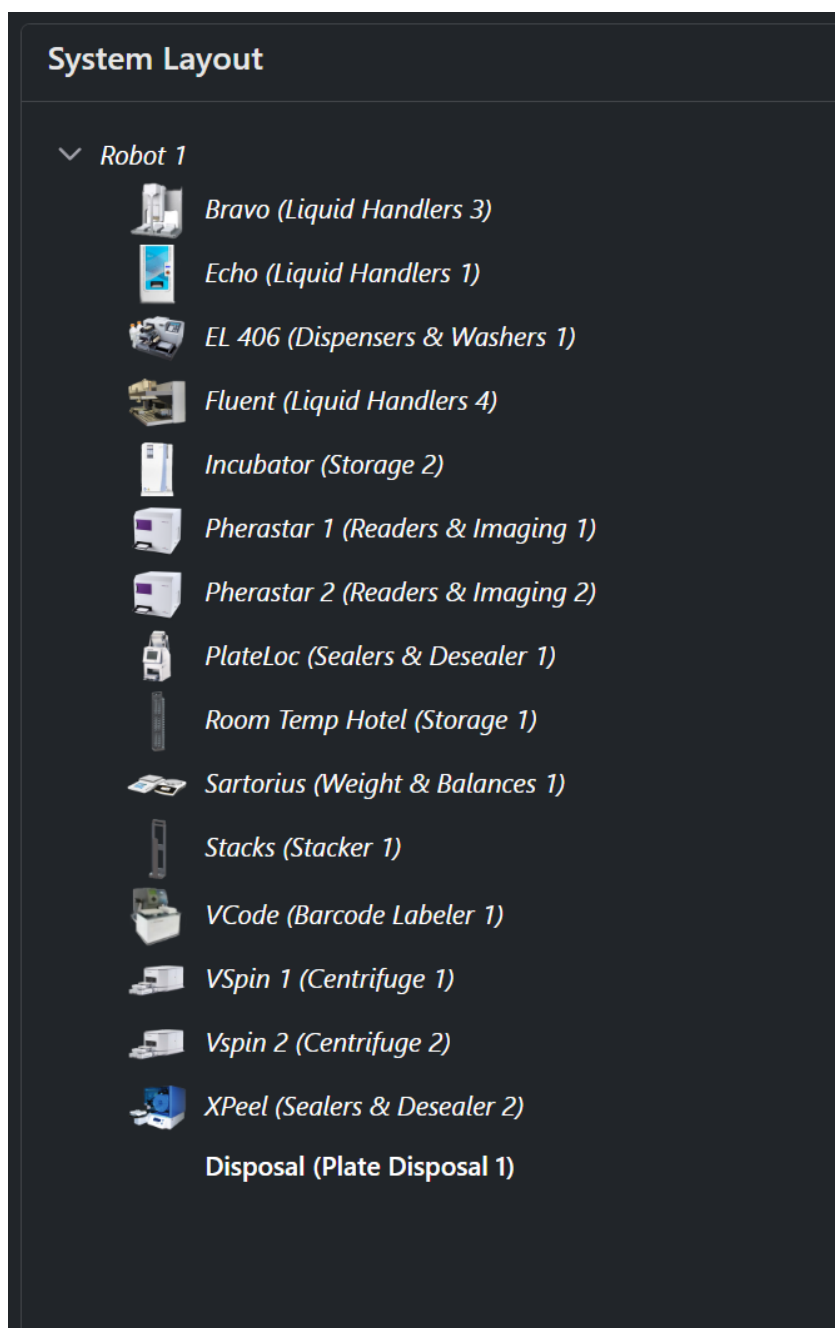


Fig. 48: Loaded System Layout

5.1.1 Device Locking

Given sufficient security permissions, the user can lock a device during run execution for the purpose of servicing the device while allowing other assay steps that do not require the device to continue running. The user locks/unlocks a device by clicking on the lock icon next to the device name.

Clicking a device in the Unlocked state queues a lock task for the device to the scheduler with the maximum task priority for the given device. If no assay step has a lock on the device, the device becomes locked immediately; otherwise, the device becomes locked as soon as the current step unlocks the device. Since the priority of the lock will be higher than that allowed for a method step, the lock is guaranteed to prevent any new steps waiting on the device from being executed.

Clicking a device in the Locked state queues an unlock task for the given device. Since the device was locked by the operator it will unlock immediately. Any method steps waiting on the device to unlock can then use the device.

If a device has an associated I/O control setup (e.g., an access drawer/door), the manual device locking for that instrument will be controlled on the I/O page instead of on the active system layout display.

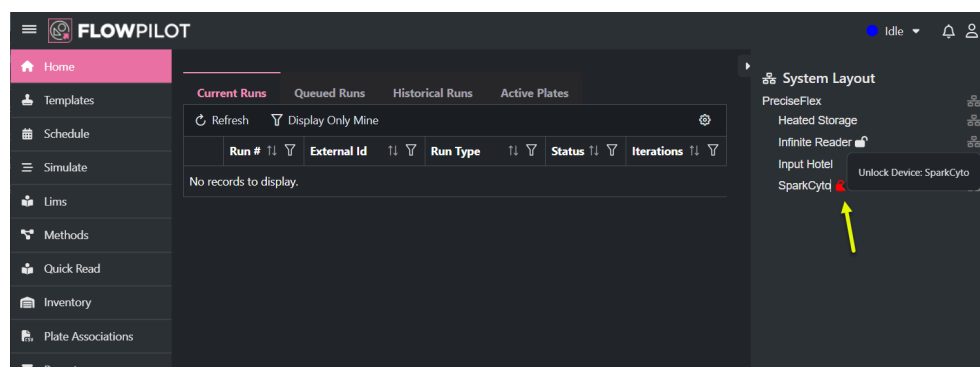


Fig. 49: Lock Device

5.2 Dashboards

There are four dashboards that display current, queued, and historical assay runs, and active plates.

- The **Current Runs** dashboard displays assays that are currently running.
- The **Queued Runs** dashboard displays all runs that are queued for execution and allows the user to change the priority of which run should be started next.
- The **Historical Runs** dashboard displays all runs that have been completed, aborted, or ended in error.
- The **Active Plates** dashboard displays plates that have been scheduled and have been introduced to the system.

All dashboards can be filtered to only include data from runs/simulations the user has initiated using the Display All/Display Only Mine button in the dashboard header. For each column filters can be applied to view specific runs matching the filter criteria. To start filtering click the filter icon in the column of interest and start typing. During normal operation, the grid is refreshed with the latest data automatically; however, in the event the user believes the dashboard data to be stale, the Refresh button can be clicked to retrieve the latest data.

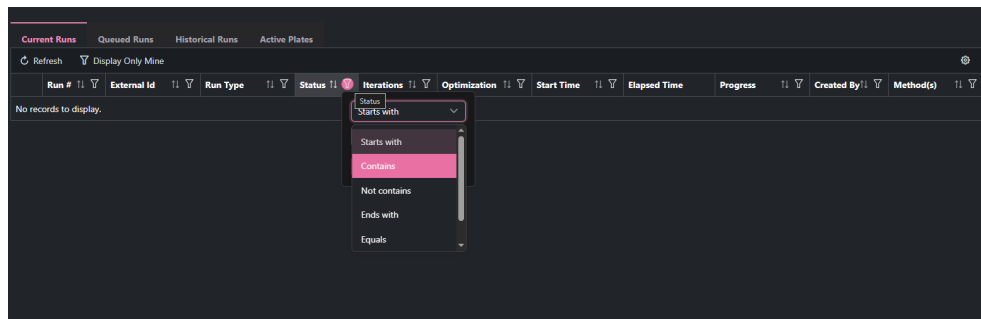


Fig. 50: Dashboards

5.2.1 Current/Historical Dashboard

The Current and Historical dashboards include screening, plate move, and inventory run data. Each row in the dashboard displays the data for a discrete assay run:

- **Run #:** Incrementing id of the run.
- **External Id:** Specified External Id.
- **Run Type:** Type of run: Screen, Inventory, Move Plate.
- **Status:** Status of the run.
- **Iterations:** Total number of Iterations in the run.
- **Priority:** Priority of the run, defaults to 0. User may modify the priority by adjusting the priority between -100 to 100.
- **Start Time:** Time run started, or scheduled time if queued.
- **Method(s):** Method file(s) specified for the run. Clicking on the method file will display the method.
- **Created By:** User who created the run.
- **Delete Run:** Allows user with appropriate role security to delete all run data.

Each row can be expanded to display additional information about the run. The first sub-grid displays the current state of each primary plate in the run:

- **Iteration:** Iteration as defined in the assay run.
- **Primary Barcode:** Barcode of the primary (first) plate.
- **Status:** Pending, Running, Complete, Aborted, or Error.

If you expand a row in this grid, the details for each barcode involved in the iteration will be displayed.

5.2.2 Queued Runs Dashboard

The Queued Runs Dashboard will display runs that are queued for execution. Runs will only stay in the dashboard when the system is configured to allow a limited number of simultaneous assays to execute (default is unlimited assays). All queued runs will be displayed in the expected order of starting.

Users with sufficient permission will be able to take the following actions:

- **Pause** the queue to prevent new assays from starting until the queue is resumed.
- **Modify** the priority of a run to move its starting position up or down the queue.

Each row in the dashboard displays the data for a discrete assay run:

- **Run #:** Incrementing id of the run.
- **External Id:** Specified External Id.
- **Run Type:** Type of run: Screen, Inventory, Move Plate.
- **Status:** Status of the run.
- **Iterations:** Total number of Iterations in the run.
- **Priority:** Priority of the run, defaults to 0. User may modify the priority by adjusting the priority between -100 to 100.
- **Start Time:** Time run started, or scheduled time if queued.
- **Method(s):** Method file(s) specified for the run. Clicking on the method file will display the method.
- **Created By:** User who created the run.
- **Delete Run:** Allows user with appropriate role security to delete all run data.

5.2.3 Active Plates Dashboard

The Active Plates dashboard displays all plates in all runs that have entered the system and are actively being used. After the iteration the plate is used in is complete, it will be removed from the dashboard.

- **Barcode:** Barcode of the plate.
- **Run #:** Run # of the plate.
- **Iteration #:** Iteration # within the specified run.
- **Location:** Current location of the plate in the inventory.
- **Step:** Current step that the plate is being used in. If the plate is not being used, it will display the current step of the primary plate.
- **Command:** Last command sent to a device that referenced the plate barcode.
- **Next Step:** Next step the plate will be used in. If blank, plate is not scheduled to be used in another step.

5.3 Visualizations

Run and simulation data can be visualized by clicking the link on the Run # or Sim #. Provided in the visualizations are Timeline charts, Method, tabular Step and Timeline data, Incubation Analysis (conditional) Device Utilization graphs (post run), and a list of run Pending Tasks (during run).

5.3.1 Timeline Charts

There are four timeline charts (Step, Iteration, Barcode, Device) that can be used to view the details of the run. The desired chart can be selected from a dropdown list on the Timeline tab. All charts are modified Gantt charts that display the details

of all primary plates and all step tasks. The user can zoom or pan the chart as desired and save to an image file. Hovering over each task will display additional details (device name, task name, duration of task).

If a run has more than 30 iterations, the chart will by default be zoomed to display the first 30 iterations. The user may change the zoom level using either the zoom in/out buttons or by using their mouse scroll wheel. The user can also pan a chart that has been zoomed in by clicking the pan icon in the upper right corner of the chart and using the mouse to pan.

Using the gear icon, the user may reset the zoom level. The user may also change the time display mode for the charts. Two time display modes are available:

- **Relative (default):** The time relative to the start that the operation took place.
- **Actual:** The actual time the operation took place.

The user preference is cached and applied to all timelines. Since simulations are independent of the actual time, they always use the relative time display mode.

5.3.1.1 Step Timeline Chart

The Step chart visualizes the run data at the Method Step level and displays discrete blocks for each step in the method.



Fig. 51: Step Timeline Chart

When a complex method is run, each branch will be displayed within the iteration so the user can visualize how the steps interact. The range of displayed iterations can be modified by using the Iteration Filters above the chart.



Fig. 52: Complex Method Chart

5.3.1.2 Iteration Timeline Chart

The Iteration chart provides a deeper level of visualization. It shows each individual task that is executed in the iteration. Each barcode utilized in the iteration will be shown in the same horizontal assay row. The range of displayed iterations can be modified by using the Iteration Filters above the chart.



Fig. 53: Iteration Timeline Chart

5.3.1.3 Barcode Timeline Chart

The Barcode chart displays like the Iteration chart; however, each task that is performed during the execution of the assay is grouped by barcode on a separate horizontal line. By default, all barcodes will be shown; the desired barcodes to be shown can be filtered using the barcode filter above the chart.



Fig. 54: Barcode Timeline Chart

5.3.1.4 Device Timeline Chart

The Device chart displays all tasks that are executed during the execution of the assay by the device that the task is performed on. This chart is useful for quickly visualizing device utilization and seeing where bottlenecks may be occurring in an assay.

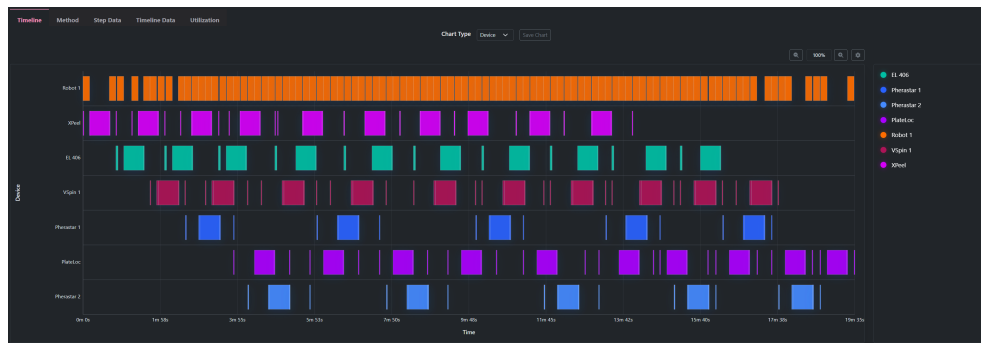


Fig. 55: Device Timeline Chart

5.3.2 Device Utilization

The Device Utilization graphs display how long each device was utilized during the assay run. When running multiple iterations of the same method, these graphs can assist the user in determining if any device is operating at a reduced efficiency.

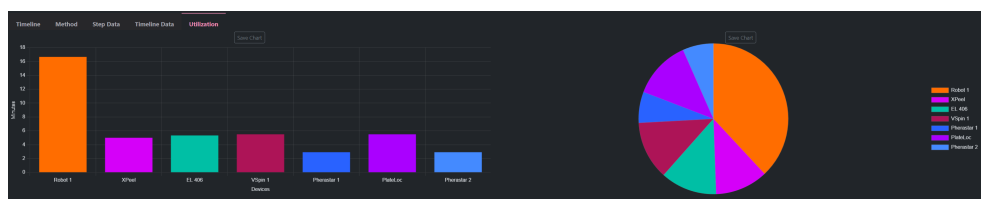


Fig. 56: Device Utilization

5.3.3 Tabular Data

The tabular data is the backing data for the charts above and is displayed in two formats: Step Data and Timeline data.

The Step data displays for each barcode the total processing duration as well as the discrete step durations. If the user clicks the link on the first cell, the displayed Timeline graph will focus the visualization on the selected item. This data can quickly be used to assess processing time and detect any outliers or issues with timing on the assay. Step data can be exported to an excel file if desired.

The Timeline data displays each discrete task that is processed through the system. The user can filter the data as desired to focus on trouble areas or to understand how the method steps were executed. Timeline can be exported to an excel file if desired.

5.3.4 Incubation Analysis

The Incubation Analysis tab will be displayed if the Method has an Incubate Step.

When a method has an incubation step, users with the appropriate permission (Modify Method During Run) can modify the incubation time for running incubation steps. To update an incubation time, navigate to an active run detail view, and click on the "Incubation Analysis" tab. Any active incubation steps will be displayed. The user can either update an individual iteration timer or update all iterations. Please note, if the operator updates all iterations and there are iterations that have not yet

started an incubation step, the original method scheduled time will be used for new iterations. To update iterations not yet started, the user must modify the method itself.

Timeline	Method	Step Data	Timeline Data	Parameters	Pending Tasks	Incubation Analysis
Incubate Method Step Scheduled Incubation Time 1 h 00 m 00 s  						
Iteration	Scheduled Incubation		Start Time	Current Timer		
1	1 h 00 m 00 s 		7/23/26 4:05:56 PM	00:00:21		

Fig. 57: Incubation Time Update

On completion of the run, each incubation step will be displayed with the incubation time for each row. These charts allow the user to easily determine if the Method needs to be adjusted to provide a consistent incubation period.



Fig. 58: Incubation Analysis

5.3.5 Pending Tasks

The Pending Tasks tab is displayed only during an executing run. The data displayed is a running list of the remaining tasks that have been queued to run. This is not a comprehensive list of all remaining tasks in the assay, as only single steps are processed and queued as they become available to be executed.

5.3.6 Method Tab

The method tab displays a visualization of the Method that was used for the run. In the event of a multi-method run, the user can select which method to display.

5.3.7 Prompts & Errors Tab

Any operator prompts/approvals or any errors that occur during the run will be displayed on the Prompts & Errors tab. The message, when it occurred, and any action taken and by whom will be recorded and displayed for tracking purposes.

Iteration #	Occurred At	Type	Message	Action Taken	Responded At	Responded By	Recovery Comments
1	1/23/25 2:21:07 PM	Error	Robot 1 Error Move Plate destination Star Additional Nest 1 is not vacant. • Retry - Retry from the start of the operation • Fault - Fault the iteration	Fault	1/23/25 2:21:11 PM	admin	
1	1/23/25 2:21:12 PM	Error	Assay row faulted: C337789316353290				

Fig. 59: Prompts & Errors Tab

5.3.8 Run Files Tab

The Run Files tab will display a list of all files that are generated as part of the assay run. The user may select files to download. If multiple files are selected, they will be packaged as a zip file for the user.

Timeline	Method	Step Data	Timeline Data	Prompts & Errors	Run Files	Device Utilization	Run Log
Select File(s) to Download *							
Search for File							
Run Files Reader Trace io_test plateAssociation.csv Test test2							
Select one or more files to download. If more than one file is selected, the files will be packaged as a .zip file for download.							
Download							

Fig. 60: Run Files

5.3.9 Run Log

The Run Log tab includes data that provides additional insight into how the run proceeded. Additional information may include run timing details, I/O changes, method or parameter updates, or assay pause/resume updates.

Timeline	Method	Step Data	Timeline Data	Prompts & Errors	Run Files	Device Utilization	Run Log
Created			Message				
5/21/25 11:42:21 AM			Queued assay with 2 iterations				
5/21/25 11:53:42 AM			Assay completed. Iterations: 2. Iterations Completed: 2. Iterations Aborted: 0. Iterations Faulted: 0. Elapsed time = 00:00:11:21.				

Fig. 61: Run Log

5.4 Aborting Runs

If the scheduler is suspended, the user will have the ability to abort the entire run or individual rows that have not been completed. When aborting the entire run, care should be taken as plates that are not in the home location must manually be removed from the device and the plate database updated in the Plate Inventory.

When aborting individual plates in the run, the user has the choice of either aborting a single plate (Abort Plate), the selected plate and all subsequent plates within the respective assay (Abort Remaining), or the selected plate and all previous plates that have not completed (Abort Previous). The aborted plates will immediately reflect an Abort Pending status, and when the scheduler is resumed, it will attempt to abort plates. If the plates are successfully aborted, the status will be

updated to Aborted; if the scheduler is unable to abort the plate it will resume the previous processing. The scheduler will resume normal processing of the remaining assay plates in the scheduler queue.

Run #	External ID	Run Type	Status	Iterations	Optimization	Start Time	Elapsed Time	Progress	Created By	Method(s)
1	K200720310340715	Assay	Complete	20	100%	7/24/26 11:03:40 AM	00:02:50	10%	Admin, System	adminTest 02
2	K200724110340716	Assay	Aborted							
3	K200724110340717	Assay	Running							
4	K200724110340718	Assay	Pending							
5	K200724110340719	Assay	Pending							
6	K200724110340720	Assay	Pending							
7	K200724110340721	Assay	Pending							
8	K200724110340722	Assay	Pending							
9	K200724110340723	Assay	Pending							
10	K200724110340724	Assay	Pending							
11	K200724110340725	Assay	Pending							
12	K200724110340726	Assay	Pending							
13	K200724110340727	Assay	Pending							
14	K200724110340728	Assay	Pending							
15	K200724110340729	Assay	Pending							
16	K200724110340730	Assay	Pending							
17	K200724110340731	Assay	Pending							
18	K200724110340732	Assay	Pending							
19	K200724110340733	Assay	Pending							
20	K200724110340734	Assay	Running	1	100%	7/22/26 3:54:45 PM	43:11:46	0%	Admin, System	adminTest 02

Fig. 62: Abort Runs

5.5 Delete a Queued Run

If a run is in the queued status, the user has the option to delete the run before it starts executing. Deleting the run will remove it from the queue and will remove all data associated with the run. Deleting a run will not reset the unique run number associated with the run.

5.6 Scheduling Runs

The user can start a run using the Schedule Run function found in the menu. A user must have the appropriate permission to start a run. There are multiple modes used to start an assay in FlowPilot.

- **Auto Generate Plate Association:** Discussed in section 5.6.1.
- **Plate Association File:** Discussed in section 5.6.2.
- **Titian File:** Discussed in section 5.6.3.

The following fields are collected from all modes used to start an assay:

Schedule

Runs can be scheduled to execute immediately or in the future; if scheduled for the future, the run will automatically start at the specified time based on the run priority and the number of executing assays; however, if the scheduler is suspended or the system is unavailable at the scheduled time, the run will start as soon as the scheduler is back online.

- **Immediate:** Start the run immediately. If the system is configured to limit how many assays may run simultaneously, the run will be added to the queue and started when able.
- **Scheduled:** Specify the earliest date/time that the assay should be started. If the system is configured to limit how many assays may run simultaneously, the run will be added to the queue and started when able.
- **When Run:** Allows the user to specify the new run should be started based on another currently queued/running assay.
 - **Run #:** Select the run to associate the new run with.

- **When:** Select the association to either be when the selected run completes or has started.
- **Delay Start By:** Add an additional delay based on the When field.
- **If Run Not Successful:** Prevents the run from starting if the associated run was not successfully completed.
- **Queue:** Add the run to the queue. If the system is not configured to limit how many assays may run simultaneously, this option will not be present.

Optimization Factor

The Optimization Factor helps the scheduler determine if the user values throughput over timing consistency in the run. When the Optimization Factor is low, runs can be completed faster, however, there may be gaps between Method Steps being executed that could impact assay results. The optimization factor works by introducing an iteration starting delay to all future iterations. The delay is determined by analyzing each method step and calculating the estimated step length; an algorithm is used to determine the optimal delay time based on the user preference for throughput vs. consistency and the method step completion times.

Additional Plate Delay

User specified iteration introduction delay that is cumulative with the system calculated Optimization Factor. Can be used to further refine timing consistency when the calculated value is not enough.

External Id

An external project or tracking id used for classification of runs.

Max Number of Iterations Running at Once

When specified, caps the number of iterations running simultaneously of a single assay to the number specified. E.g., if 50 iterations are to be run, and 15 is entered, iteration 16 will not be started until iteration 1 has been completed. This is helpful when optimizing for consistency, when caching plates with a limited number of storage locations, or when using the same device multiple times in a single method.

Run Description

Additional information the operator can provide to provide context to the run. It is searchable when running reports that include multiple assay runs.

Update Method Simulation Times

Users with the 'Can Update Method Sim Times' permission will have the option to request the selected method(s) simulation times be updated at the conclusion of the assay based on actual timings experienced during the run. The timings will be based on the average time to complete robot moves and device operations for all iterations in the run. The UI Configuration Setting "Display Update Method Sim Times" can remove the field from all users if desired.

Run Priority

By default, the Run Priority field will be set to "Normal". If the user opts to raise or lower the Run Priority, the selected method file(s) will be modified so that each Method Step priority will be increased/decreased by a proportional amount (Note:

prior to this feature, a user could change the run priority by manually adjusting the step priorities). The UI Configuration Setting “Display Run Priority” can remove the field from all users if desired.

Method File(s)

All runs require the user to specify the Method file(s) to be used. It is possible to select multiple methods on a single run. When this is done, the methods are alternated sequentially by primary plate. For example, if two methods are specified all odd iterations are associated with the first method and all even iterations are associated with the second method. Typically, multiple methods on a single run are used to take advantage of parallel peripheral devices if pooling is not desired (e.g., multiple dispensers or plate readers). In this case each method is the same except which peripheral device step utilized. This allows the run to execute those steps in parallel on separate devices. This is an alternative used to device pooling, or when a user needs a plate to visit the same device in multiple steps in the assay (e.g., a capper/decapper) but wants to increase speed by having multiple devices used.

Pre- and Post-Execution Methods

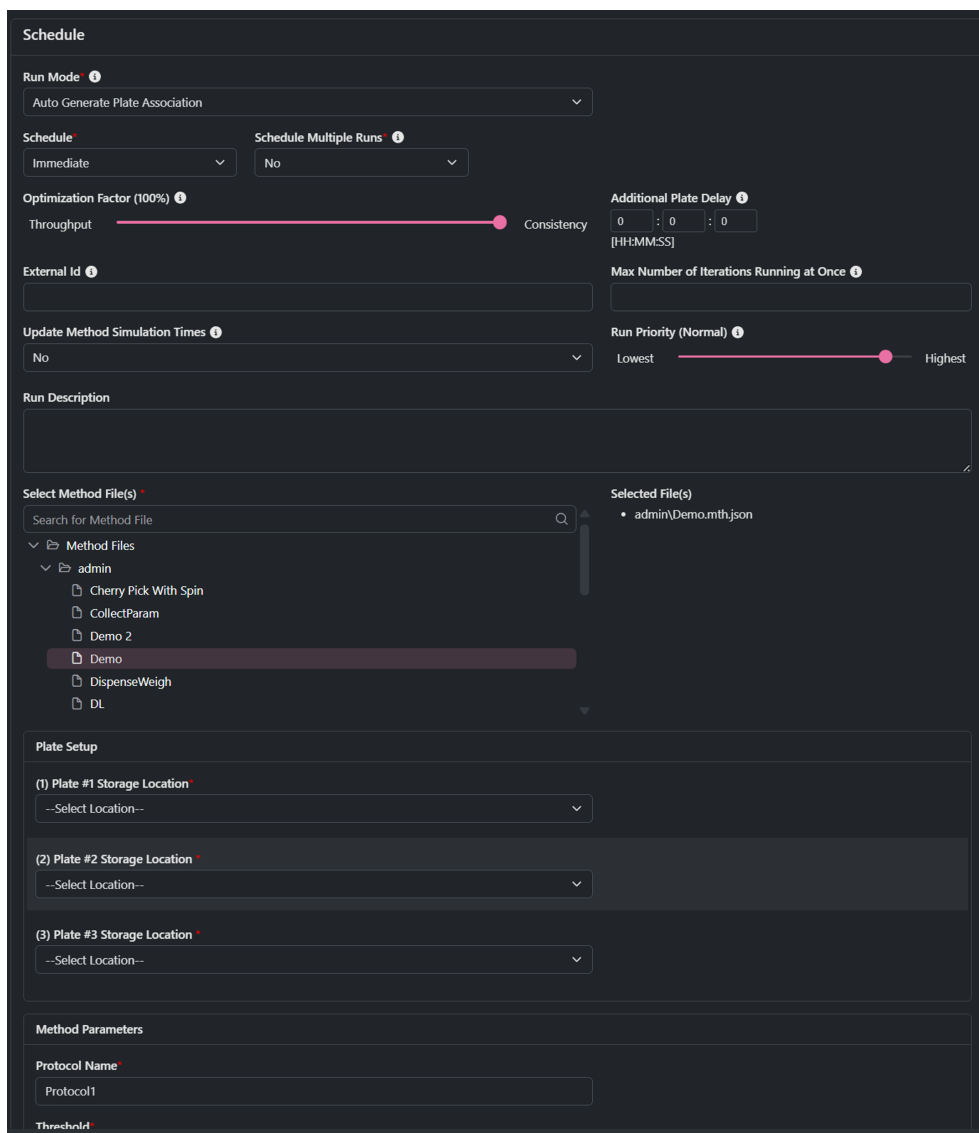
In addition to the main method(s), users can define one method each to be run as a separate assay run before and after the main assay runs have completed. These options need to first be enabled in the UI Configuration Settings. Pre/post-execution methods work similarly to methods scheduled using the Schedule Assay method step. The selected method needs to have the same number of plates or fewer as defined for the main method(s). The plates of the main methods run are mapped to the plates of the pre/post-execution methods. For the pre-execution method, the user can decide if the assay run needs to be successful for the main assay run(s) to be executed. For the post-execution method, the user can decide if the main assay run(s) need to be successful for the post-execution method to be run. If the validation of any of the pre/main/post methods fails during scheduling, the entire schedule will be considered invalid and the already scheduled runs will be aborted. The pre-execution run happens once before any of the main assays have been run, while the post-execution run happens once after all the main assays have completed. In the Current/Historical Runs tabs of the Home page, the pre/post assay runs are displayed similar to assays started from another method, where they cannot be cloned and the External Id column displays their type (Pre/Post) and the ID of the parent assay run.

5.6.1 Auto Generate Plate Association Mode

The Auto Generate Plate Association run mode initiates a run without the user having to specify the relationship between barcodes of the labware for a single iteration. The storage location of each plate used in the method will be selected with the starting index, and each iteration will sequentially pull the plates from the storage until the number of specified iterations have completed.

- **Storage Location:** Select the storage location of the plate.
- **Start Index:** Select the index of the plate for the first iteration to be run.
- **Total Iterations:** Primary plate only. Enter the number of iterations of the method to be run.
- **Barcode Management:** Changes how plate barcodes will be managed for this plate line:

- **Standard:** Use plate barcode. If the storage location is not inventoried prior to run start, a proxy barcode will be generated, and the plate will be inventoried on first move.
- **Auto Barcode:** Generate a barcode for the plate based on the Auto Barcode Prefix and Counter settings. Ignores any printed barcode on the plate. Must be enabled in the system settings.
- **Proxy Barcode:** Generate a barcode for the plate based on a timestamp if no current inventory record exists. Ignores any printed barcode on the plate.
- **Require Re-Inventory:** Delete pre-existing inventory records for selected plates prior to run initialization and all plates will be re-inventoried on first move.
- **Plate Type:** Select the plate type for this plate.
- **Lid Type:** Select the lid type for this plate.
- **Distribution Type:** Non-primary plates only. The Distribution Type alters how this plate line will be associated to the primary plate line.
 - **One to One:** A unique plate will be associated with each primary plate.
 - **Single Plate:** A single plate will be used and associated to all primary plates
 - **Reformatting:** Quadrant: The plate will be used for 4 iterations before a new plate will be introduced. Useful when reformatting plates.
 - **Reuse:** Selects the specified number of primary plates that will be processed before a new Cell A plate will be used (e.g. A,A,B,B,C,C).
 - **Rotate:** Selects the specified number of unique Cell A plates and rotates for every primary plate (e.g. A,B,C,A,B,C).



Schedule

Run Mode ⓘ
Auto Generate Plate Association

Schedule ⓘ
Immediate

Schedule Multiple Runs ⓘ
No

Optimization Factor (100%) ⓘ
Throughput Consistency

Additional Plate Delay ⓘ
0 : 0 : 0
[HH:MM:SS]

External Id ⓘ

Max Number of Iterations Running at Once ⓘ

Update Method Simulation Times ⓘ
No

Run Priority (Normal) ⓘ
Lowest Highest

Run Description

Select Method File(s) ⓘ
Search for Method File

Method Files
admin
Cherry Pick With Spin
CollectParam
Demo 2
Demo
DispenseWeigh
DL

Selected File(s)
• admin\Demo.mthjson

Plate Setup

(1) Plate #1 Storage Location ⓘ
--Select Location--

(2) Plate #2 Storage Location ⓘ
--Select Location--

(3) Plate #3 Storage Location ⓘ
--Select Location--

Method Parameters

Protocol Name ⓘ
Protocol1

Threshold ⓘ

Fig. 63: Auto Generate Plate Association Mode

5.6.2 Plate Association File Run Mode

The Plate Association File run mode initiates a run using the traditional Plate Association file. This mode is used for more complex scenarios (e.g., plates spread across multiple storage devices). For details on the Plate Association file, see Section 4.3.1. The file specified will be parsed and validated before the run is queued with the scheduler.

When using the Plate Association File Run Mode, the following additional fields are collected from the operator:

- **Plate Type:** Select the plate type for this plate.
- **Lid Type:** Select the lid type for this plate.

Fig. 64: Plate Association File Mode

5.6.2.1 Auto Associate

When using the Plate Association run mode, a user may select the primary plates to have the barcode assigned at run time by entering “AUTO” instead of a barcode. FlowPilot will determine the number of primary plates required by the number of rows in the plate association file. FlowPilot uses this number and the starting index specified by the user to determine the range of plates used in the run.

FlowPilot then queries the plate database to determine if there are any plates in the inventory in this range of the selected storage location. If no plates are returned by the query, the plates will be inventoried during the first use of each plate. If the number of plates available in the selected storage is less than the number of plates required, the run will not be allowed to start. If validation passes, the assay is queued with the scheduler.

Since the barcode association is not explicitly defined by the user, FlowPilot will generate a separate file (found in the Run Files tab) containing the actual plate association. This will be a csv file in the same format as a regular plate association file. Entries are added to this file as the associated primary plates are completed (successfully or not). If row is terminated before the primary plates barcode has been determined (either by an inventory operation or the plate table), the corresponding primary plate barcode in the association file will read “—NONE—”. The plate association file generated by the software will have the same name as

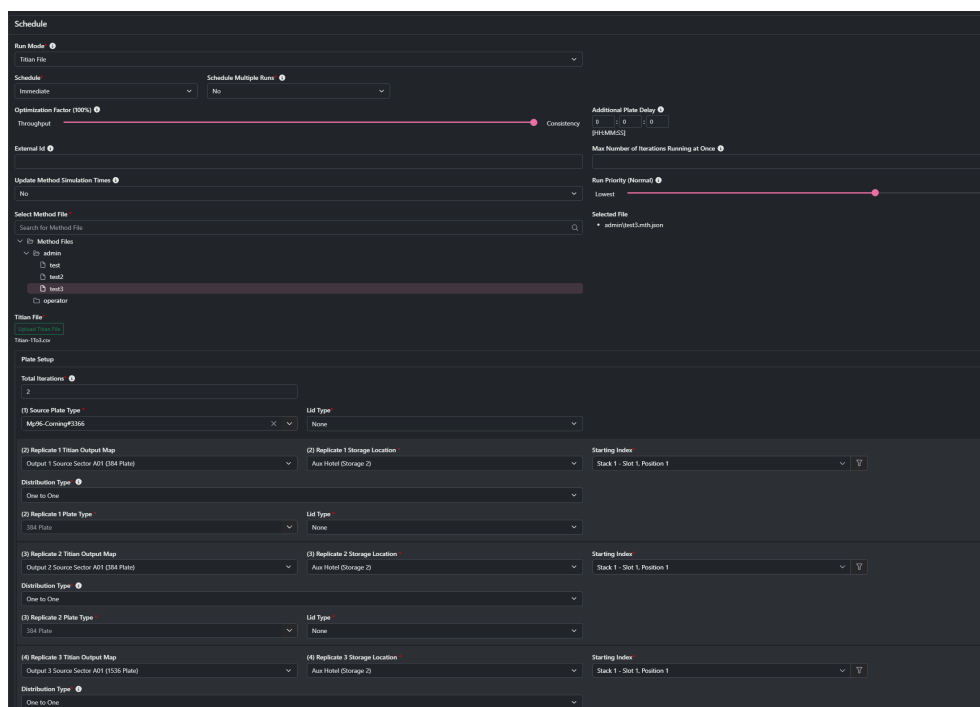
the plate association file selected by the user with a tilde (~) character inserted at the end of the file name and before the .csv extension. If this file already exists in the run folder, it will be overwritten.

5.6.3 Titian File Start Mode

If the FlowPilot instance is licensed for a Titian integration, the option to start using a Titian Mosaic File will be available. The Titian Mosaic file must meet the following requirements to be considered a valid file:

- All Source barcodes must be defined.
- All Output barcodes for a specific output must either be defined or not.
- All Output barcodes for a specific output must have the same plate type.
- All Source plates must have the same number of outputs.
- All required columns are present.
- The Titian File has the same or fewer number of defined outputs plus 1 as the Method configured plates (e.g., 4 outputs + 1 source plate = 5 configured plates in the method file minimum).
- All labware specified in the Titian Mosaic file must be available plate types in FlowPilot.

When running in the Titian Mosaic file mode, the “Source” barcode from the Titian file will always be the first/primary plate defined in the method file plate configuration. All additional plate configurations defined in the method file must be mapped to the applicable Titian Mosaic file “Output,” and if the barcode not defined, the starting location and index specified (see section 5.6.1 for field definitions when selecting locations details).



The screenshot displays the 'Schedule' window in FlowPilot. At the top, 'Run Mode' is set to 'Titian File'. Below this, 'Optimization Factor (100%)' is set to 'Throughput'. 'External ID' is empty. 'Update Method Simulation Times' is set to 'No'. Under 'Select Method File', 'Method Files' are listed, including 'admin', 'test', 'test2', 'test3', and 'operator'. The 'Titian File' section shows 'Titan-Tickles'. The 'Plate Setup' section indicates 'Total Iterations' of 2. Below this, three replicates of 'Titian Output Map' are configured. Each replicates section includes 'Source Plate Type' (e.g., 'My96-Connex92336'), 'List Type' (e.g., 'None'), 'Distribution Type' (e.g., 'One to One'), and 'Storage Location' (e.g., 'Aux Hotel (Storage 2)').

Fig. 65: Titian Mosaic File Mode

The accepted Titian Mosaic file can be used for Replication or Reformatting based assays; a special parameter will be present on Liquid Handler based method steps asking if Titian Mosaic Overrides should be applied to the step. This is designed to work when the “Source” plate from the Titian Mosaic file is loaded to the primary nest on the liquid handling device. When selected, FlowPilot will analyze the uploaded Titian file when the step is processed and will send special parameters to the driver that can be applied to the protocol being run to modify the following attributes:

- Transfer Volume: taken directly from the Titian Mosaic file based on the mapping specified in the starting parameters.
- Quadrant: If the plate sizes are the same or the source plate is smaller, the quadrants will be set as “A01”. If the Source plate is $\frac{1}{4}$ the size of the Destination plate, the quadrant will be updated based on the iteration being processed. The quadrant is calculated by taking the modulus of the iteration number and 4, with the result being used to set the quadrant.
 - 1: A01
 - 2: A02
 - 3: B01
 - 4: B02

Titian Integration

Apply Titian Mosaic Overrides*

☒ Yes
 ☐ No

If the run was started using a Titian Mosaic file, apply transfer volume and quadrant changes to method step

Fig. 66: Liquid Handler Titian Integration

5.6.4 Schedule Multiple Runs

When needing to schedule runs for a kinetic assay, a new option is available to schedule a series of assays on a scheduled basis.

Schedule

Immediate

Schedule Multiple Runs

Yes

Schedule X Time(s)

2

When

Previous Assay Starts

Time Between Starts

0 : 1 : 0

[HH:MM:SS]

Fig. 67: Schedule Multiple Runs

To schedule multiple runs:

- Select either Immediate or Scheduled for the Schedule start type.
- Select Yes for “Schedule Multiple Runs”.
- Enter the number of times that assay should be repeated.
- Enter the time between starting the assay. This is a set time from the start of each assay; if the previous assay is still running, the next assay will still attempt to start at the scheduled time.

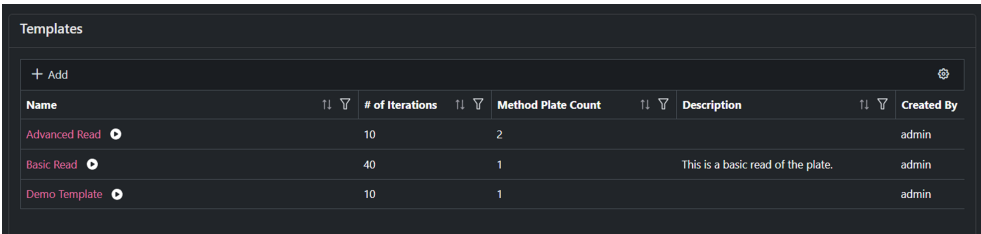
All scheduled assays will be added to the assay queue and can individually be cancelled or prioritized as needed.

5.7 Templates

The “Template” feature allows a user to create a template run that can be saved and executed by other users (note: the only supported run mode is “Auto Generate Plate Association”). There are two permissions that control the use of the Template feature:

- **Start a Template:** Allows the user to start a template from the Template page (even if the user does not have the “Start Run” permission).
- **Save a Template:** Allows the user to save a new template and edit or delete an existing template.

Existing Templates are accessed from the “Templates” menu item, if the user has either of the permissions enabled.



Name	# of Iterations	Method Plate Count	Description	Created By
Advanced Read	10	2		admin
Basic Read	40	1	This is a basic read of the plate.	admin
Demo Template	10	1		admin

Fig. 68: Templates

If the user has the “Save a Template” permission, the name of the template can be clicked to update the template, and a “trash” icon will be present allowing deleting of the template. If the user has the “Start a Template” permission, a “play” icon will be present that can be clicked to immediately queue the template.

To create a new template, the user can click the “New Template” button on the Templates page or directly visit the Schedule page. Complete the Schedule form as if to schedule a run (note: the “Run Description” field will be displayed in the Template list as the “Description” if filled out); instead of clicking the “Schedule” button, the “Save Template” button will be clicked. A dialog box will be presented to allow a unique template name to be entered.

5.8 Quick Read

If there is a plate reader configured in the System Layout, a special purpose “Quick Read” assay can be quickly started. The operator is required to select the following:

- **Storage Location:** Any Auxiliary Hotel configured in the System Layout.
- **Indexes to Read:** Either All indexes in storage location or user selected range.
- **Starting/Ending Index:** Starting and Ending index range if selected by the user.
- **Plate Type:** The plate type.
- **Lid Type:** The lid type.
- **Priority:** Priority of the plate read assay relative to other running assays.
- **Auto Barcode:** If configured to allow, assigns a runtime barcode to the plate.
- **Delete Plates from Inventory:** Deletes the plates from inventory when complete. Does not physically remove the plate from the system.
- **Plate Reader:** Any plate reader configured in the System Layout.

- **Additional Fields:** Any additional fields required by the specified plate reader.

The Quick Read run will move the selected plate(s) from the storage device to the plate reader, commence the read, and move the plate back to the original storage device when the read is complete.

Fig. 69: Quick Read Run

5.9 Simulations

Operators are encouraged to simulate a run via the Simulate feature. Simulations are processed via a simulation scheduler that has no communication with downstream devices. In most cases, simulations will only take a few seconds to complete. A simulation will run through all method steps and uses the simulation times specified in each method step for the Load, Unload, and primary device operation tasks; if the simulation times do not accurately reflect device operation, the simulation will not be accurate.

Barcodes in the storage devices are simulated in both the Auto Generate Plate Association and Plate Association File run modes. The storage devices must be specified and must have capacity for the number of plates requested to be simulated.

In the event the simulation scheduler becomes deadlocked due to an error in the method, the system will attempt to make recovery moves to resolve the deadlock after a fixed amount of time (default 1 minute). If unable to be automatically resolved, the scheduler can be restarted via the Reset Simulation Scheduler link in the Scheduler status menu. If additional devices are added to the System Layout, the simulation scheduler will need to be restarted before starting a simulation using the new devices.

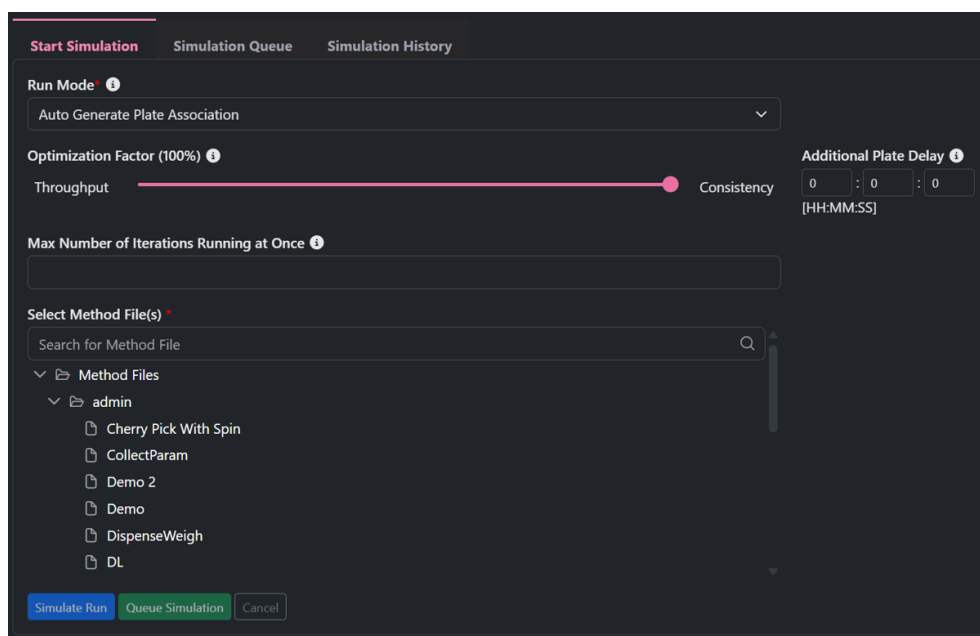


Fig. 70: Simulations

5.9.1 Start Simulation

When a user navigates to the Simulate page, the simulation may either be started immediately as a standalone simulation (traditional way to run simulations), or the simulation can be placed on the simulation queue. Any simulations placed on the queue will be visible on the Simulation Queue tab, where the start time can be adjusted and the queue started. If a single simulation is running, the queue will not be able to be started; if a queue is running, a single simulation will not be able to be started.

5.9.2 Simulation Queue

On the Simulation Queue page, the user may adjust the “Simulation Start Delay” for each of the simulations. At least one simulation must have a start delay of 0 or the queue cannot be started. The start delay for each listed simulation is calculated from the initial starting time of the first simulation. A queued simulation can be removed from the queue if it was mistakenly added. The queue can be started by clicking the “Run Queue” button. When multiple simulations are run, the barcodes are simulated for the desired plates in order the runs are started. If a plate association run is simulated, the plates will be placed in the first available location in the chosen storage device. If a subsequent scheduled auto generate simulation uses those locations, the barcodes will be reused in that run.

5.9.3 Simulation History

The Simulation dashboard displays all simulations conducted, and each row represents an individual simulation:

- **Sim #:** Incrementing id of the simulation. Includes link to assay visualizations.

- **Sim Group:** If the simulation was run as a multiple-run simulation, the simulation will be included. A link will provide visualizations of all runs in the multiple-run simulation.
- **Complete:** Indicates if the simulation has completed: Yes/No/Aborted/Deadlocked.
- **Estimated Run Time:** Estimated run time of an assay initiated using the same parameters. The simulation run time is approximated using the Simulation Times defined in each method step.
- **Iterations:** Number of iterations simulated.
- **Optimization:** Optimization factor specified by user when scheduling the run.
- **Method File:** Method file used for the simulation.
- **Created By:** User who created the assay run.
- **Clone Simulation:** Allows user to schedule a new simulation based on the parameters used in the simulation being cloned.
- **Delete Simulation:** Allows user with appropriate role security to delete all simulation data.

Simulation History										
Sim #	Sim Group	Complete	Estimated Run Time	Iterations	Optimization	Plate Delay	Max Iterations Running at Once			
95		Yes	2 h 42 m 42 s	5	100%	N/A	N/A			
94		Yes	0 h 26 m 40 s	10	100%	N/A	N/A			
93		Yes	0 h 19 m 36 s	10	100%	N/A	N/A			
92		Yes	0 h 15 m 13 s	1	100%	N/A	N/A			
91		Yes	0 h 11 m 20 s	3	100%	N/A	N/A			
90		Yes	0 h 07 m 50 s	3	100%	N/A	N/A			
89		Yes	0 h 05 m 04 s	2	100%	N/A	N/A			
88		Yes	0 h 02 m 18 s	1	100%	N/A	N/A			
87		Yes	0 h 01 m 40 s	1	100%	N/A	N/A			
86		Yes	0 h 01 m 40 s	1	100%	N/A	N/A			
85		Yes	0 h 01 m 39 s	1	100%	N/A	N/A			
84		Yes	0 h 01 m 39 s	1	100%	N/A	N/A			
83		Yes	0 h 01 m 39 s	1	100%	N/A	N/A			
82		Yes	0 h 01 m 39 s	1	100%	N/A	N/A			
81		Yes	0 h 01 m 39 s	1	100%	N/A	N/A			
80		Yes	0 h 03 m 00 s	1	100%	N/A	N/A			
79		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			
78		Deadlocked	N/A	1	100%	N/A	N/A			
77		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			
76		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			
75		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			
74		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			
73		Yes	0 h 01 m 53 s	1	100%	N/A	N/A			

Fig. 71: Simulation History

On the Simulation History grid, a new “Sim Group” column has been added that the user can use to view the composite view of all simulations run as part of the queue. If an individual simulation is viewed via the Sim # column, the starting time of the simulation will be based on the Simulation Delay time that was selected by the user.

5.9.4 Schedule Now

When a user navigates to the Simulate History page, the simulation may either be duplicated as a new standalone simulation or can be scheduled to run as a real assay by pressing the calendar icon. Any parameters defined for the simulation will

be carried over into the scheduling page. Certain parameters will still need to be entered since not every parameter needed by a real assay is part of a simulation and are instead populated with a default (e.g. Plate Type and Lid Type).

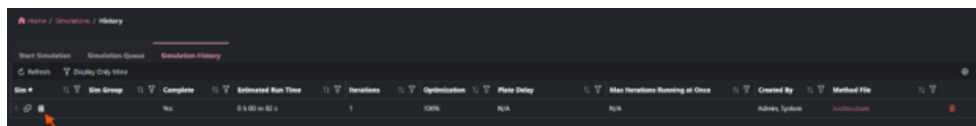


Fig. 72: Schedule Now

5.10 Scheduler

The scheduler is the core execution engine of FlowPilot. The primary function of the scheduler is to maintain the list of all runs and schedule tasks associated with the method steps for execution based on the scheduling policy. A task is defined as the fundamental unit of work for the scheduler (i.e., moving a plate, ejecting a device nest). When a run is queued to the scheduler for execution, the scheduler maintains a list of all steps required to execute the assay and will break each step into its subordinate tasks when the step is ready to execute.

5.10.1 Scheduler Status

The scheduler status is always viewable in the menu bar.

- **Disconnected:** The scheduler was unable to start successfully. Check the System Message log for causes.
- **Idle:** Scheduler started successfully and is waiting for a run to execute.
- **Running:** Scheduler is currently executing a run.
- **Suspended – Tasks Completed:** Scheduler has been requested to suspend. Any currently running tasks will complete, and no new tasks will be processed.
- **Suspended:** Scheduler execution was suspended and will not process any further tasks until resumed.

Given appropriate security permissions, the user can take the following actions to manage the scheduler:

- **Restart:** Available in all statuses. Note that any running runs will be aborted and may require manual operator intervention to reset devices and plates.
- **Suspend:** Requests that scheduler execution be suspended. Available in Idle or Running status.
- **Resume:** Requests that the scheduler execution be resumed. Available in Suspended status.
- **Reset Simulation Scheduler:** Resets and restarts the Simulation Scheduler

5.11 Error Recovery

FlowPilot provides multiple paths for error recovery in the event an error is encountered during a run. It is imperative that any user performing error recovery understands the implications in this section.



NOTICE

Failure to correctly recover from an error

Failure to correctly recover from an error can result in an aborted assay, damage to equipment and loss of reagents.

If the Prevent Warning Prompt setting has been enabled in FlowPilot Settings and the error is considered a warning, an entry is made in the run error log, and the error recovery sequence is bypassed without prompting the operator for an acknowledgment.

All other errors require intervention and an error recovery response from the operator. The error recovery sequence is defined in the remainder of this section.

1. An entry is made in the run error log.
2. If a matching entry is found in the Automatic Error Handling Library, the automatic action selected is processed and the error recovery has completed.
3. The siren and pager are triggered if they have been enabled in FlowPilot Settings.
4. If the Suspend Scheduler on Fault option is enabled in FlowPilot Settings, the scheduler is suspended, and system door locks are disengaged when all devices have reached a safe (idle) state. Otherwise, the scheduler will continue queuing tasks for execution, and any system door locks remain engaged.
5. The error recovery dialog is displayed. This dialog displays the date, time, and message for the fault.

Error Recovery

Run # 116 Iteration # 1

Date 5/14/26 11:50:32 AM

Error Message
Fluent Error
This is a test error message.

- **Retry** - Retry from the start of the operation
- **Ignore** - Ignore the error and continue at the next operation
- **Fault** - Fault the operation

Recovery Comments

Add to Automatic Error Handler Create Error Snapshot Select Recovery Option Alarm Off

Fig. 73: Fault Recovery Dialog

6. The following options may be available to the user to manage the fault:
 - **Retry:** The task that caused the error will be retried. If an error still occurs when the task is retried, another error will be generated. Depending upon the type of error, the retry option may not be available.
 - **Ignore:** The task that caused the error will immediately be marked complete, treating that command as having completed successfully and the next task will be run (which could include moving the plate). This option is useful when reagent has been dispensed or transferred to the plate successfully, but some downstream error has occurred. In this case retrying the operation is not desirable since the reagent would be dispensed or transferred again, nor is faulting the plate desirable since it would result in the loss of an otherwise usable plate. Ignoring the error simply allows the plate to continue running as if no error had occurred in the first place. Extreme care should be taken when ignoring errors. In general, such an error still indicates there is a problem that requires operator intervention. Simply ignoring the error without addressing the root cause can at best lead to the same error on a subsequent plate or in the worst case a robot crash or damage to equipment. Depending on the error, the ignore option may not be available.
 - **Fault w/ Auto Plate Recovery:** Terminates the iteration that had the error occur using automatic plate recovery.
 - **Fault w/ Manual Recovery:** Terminates the iteration that had the error occur, requiring the operator to remove plates from the system.
 - **Alarm Off:** Turns off the pager and siren if enabled.
 - **Add to Automatic Error Handler:** Opens the Add Error Library Entry screen with the error text pulled from the error message. After adding to the library, the operator will still need to select the recovery option for the initial error to finalize recovery.
7. **Fault w/ Auto Plate Recovery:** If the user opts to fault and has the system automatically recover plates, a list of plates that the system will attempt to auto recover will be displayed. If the plates are not in the listed locations, the system will not be able to auto-recover, and the operator should opt to manually recover instead. If a Plate Disposal location has been defined for the system, the user may opt to send any of the iteration plates not at their home location to a specified plate disposal. If a plate has a cache location defined and Return to Home is selected, the plate will be moved to the cache location and the operator will need to manually clear the cache location and move the plate home. When auto recovery occurs, the following actions will occur:
 - FlowPilot will cancel all steps in the iteration that have not yet begun to be processed.
 - All running steps that are not impacted by the current error will continue until they are complete.
 - All remaining tasks in the step that caused the fault will be cancelled.
 - After all running steps have completed, FlowPilot will create a Plate Recovery step to move all plates to their home/cached/disposal position.

Error Recovery

Run #

116

Iteration #

1

Date

5/14/26 11:50:32 AM

Error Message

Fluent Error
 This is a test error message.

- Retry** - Retry from the start of the operation
- Ignore** - Ignore the error and continue at the next operation
- Fault** - Fault the operation

Recovery Comments

You have chosen to fault the current iteration with Automatic Plate Recovery. The following actions will occur:

- FlowPilot will cancel all steps in the iteration that have not yet begun to be processed.
- All running steps that are not impacted by the current error will continue until complete.
- All remaining tasks in the step that caused the fault will be cancelled.
- After all running steps have completed, FlowPilot will create a Plate Recovery step to move all plates to their home/cached position.

The following plates are associated with the iteration being faulted.
 The plates are currently recorded as being at the locations listed below.
 If the plates are not in the indicated locations, they must be manually placed there for auto recovery to work correctly.

Barcode	Location	Index
V402521947120559	Fluent Primary Nest	1

Please confirm you wish to proceed.

Cancel

Confirm

Fig. 74: Fault w/ Auto Plate Recovery

- Fault w/ Manual Recovery:** If the user opts to fault and manually recover the iteration, a list of all plates and locations in the system for the current faulted iteration will display. At this point, the operator must physically remove any of the plates (and lids) that are not in a dedicated storage device and acknowledge removal by clicking the checkbox on appropriate rows. By default, it is assumed none of the associated plates have been physically removed so it is imperative the operator acknowledges the physical removal of any plates. When the operator has completed removing any plates and lids associated with the faulted iteration, acknowledged their removal, and save is pressed, plates that were marked as removed are removed from the inventory, any device locks the iteration has acquired are removed and the iteration is considered faulted. At this point any additional iterations that were blocked by the error will continue.

Error Recovery

Run #
116

Iteration #
1

Date
5/14/26 11:50:32 AM

Error Message
Fluent Error
This is a test error message.

- **Retry** - Retry from the start of the operation
- **Ignore** - Ignore the error and continue at the next operation
- **Fault** - Fault the operation

Recovery Comments

You have chosen to fault this iteration and manually recover. Please confirm you wish to proceed.

The following plates are associated with the iteration being faulted.
Please confirm the location of each plate and physically remove all plates and respective lids which are not in a storage device.

Barcode	Location	Index	Removed?
V402521947120559	Fluent Primary Nest	1	☐

Cancel

Confirm

Fig. 75: Fault w/ Manual Recovery



If a plate and its lid are physically removed from the system but not acknowledged as removed, the plate remains in the inventory database. If the plate is listed as being in a nest, it will cause any move to this location to error since the destination location is checked for vacancy before allowing a move. In general, this error condition is irrecoverable.

If the error dialog is dismissed and not immediately addressed, the user can find error notifications in the menu bar by clicking on the bell icon. Any unresolved fault will display, and the dialog can be viewed by clicking on the entry.

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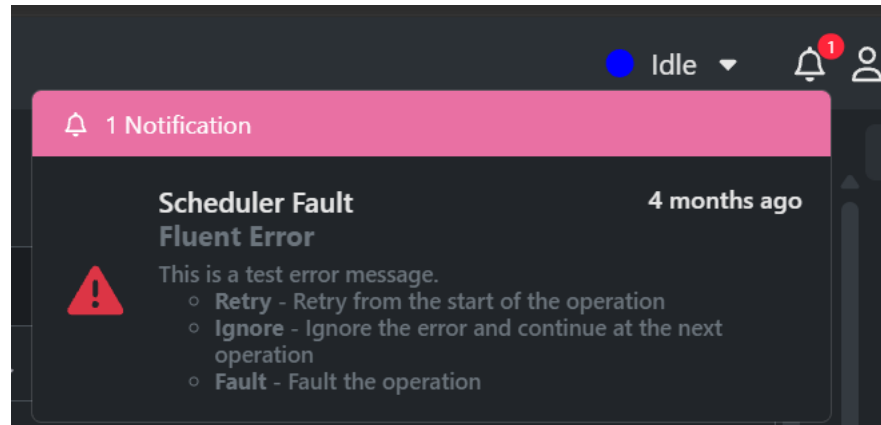


Fig. 76: Fault Notifications

5.12 Error Snapshots

If an error occurs that cannot be resolved by an end user, the fault notification includes a button to create an error snapshot. This will gather all relevant files into a zip that can be downloaded and provided to customer support for aiding in troubleshooting. Once created, a download button will allow a user to download the relevant zip file.

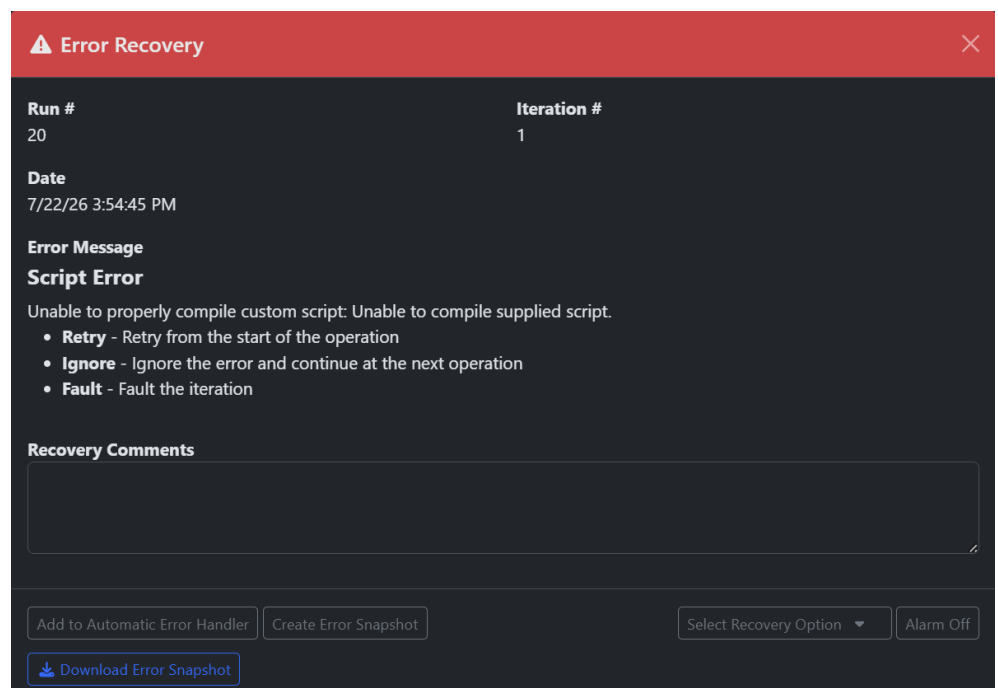


Fig. 77: Error Snapshot

5.13 Automatic Error Handling Library

The Automatic Error Handling Library allows operators to automate error recovery responses for selected errors to reduce the number of manual interventions during an assay run. Errors can be added manually or by clicking on the Add to Automatic Error Handler button on the error recovery dialog.

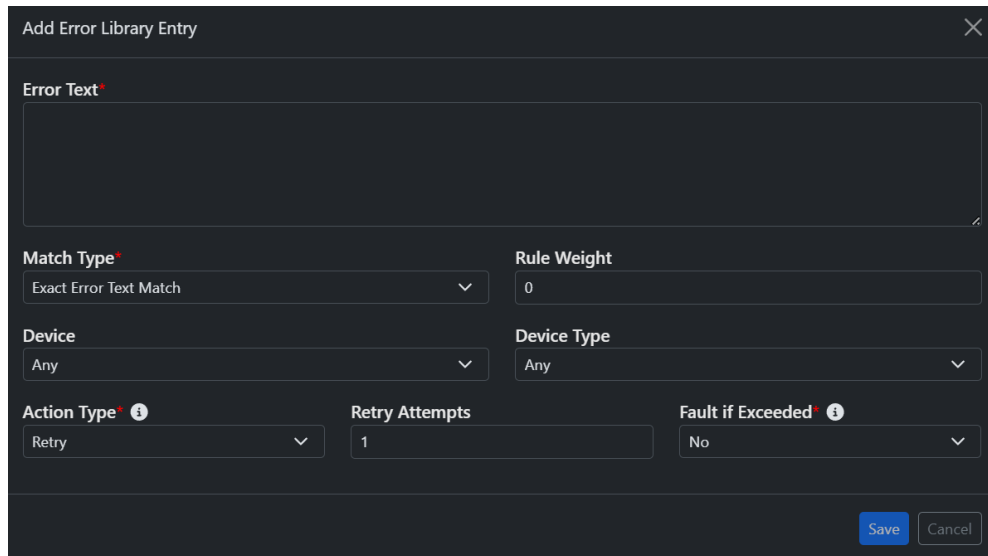


Fig. 78: Error Library Entry

When adding an entry to the Error Handling Library, the following fields will need to be filled out:

- **Error Text:** The text to compare to the full error message in the error.
- **Match Type:**
 - **Exact Error Text Match:** The error message must exactly match the entered Error Text.
 - **Error Text Contains:** The error message contains the entered Error Text.
 - **Error Text Starts With:** The error message starts with the entered Error Text.
- **Rule Weight:** When multiple entries may match, the rule weight helps determine which entry will be selected to be processed. The weight is a number between 0 to 100, with 100 being the highest weight.
- **Device/Device Type:** Used to filter the entry to a specific device or device type.
- **Action Type:** The action to take when this entry is processed.
 - **Ignore:** Ignores the error and marks it as complete.
 - **Retry:** Retries the command that failed.
 - **Retry Attempts:** The number of times to retry the exact error caused by the same task in the iteration before either faulting or presenting to the operator.
 - **Fault If Exceeded:** If 'Yes' is selected, the system faults the iteration once the configured number of retry attempts has been exceeded. The system then attempts automatic plate recovery.

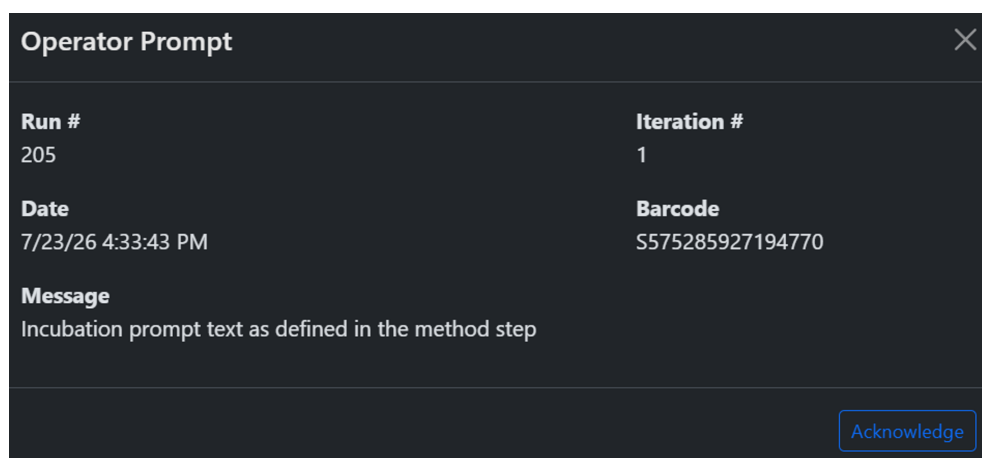
- **Fault Iteration:** Faults the iteration and attempts an automatic plate recovery.

When an error is detected in the system, FlowPilot will search for any entries that match the Error Text and Match Type. If more than one entry is found, the system will select the “best fit” using the following rules:

- Exact Error Text Match
- Rule Weight
- Error Text Starts With
- Error Text Contains
- Error Text matching length

5.14 Incubation Prompts

If the method contains an incubation step and the step uses the incubation prompt, at the specified time the Incubation Prompt will be displayed. The user can choose to acknowledge or dismiss the prompt. If dismissed, the user can re-display the prompt by clicking the bell icon in the menu bar and selecting the prompt. If an incubation prompt is not acknowledged, the plate will not move to the next step until the operator has acknowledged it.



Run #	Iteration #
205	1

Date	Barcode
7/23/26 4:33:43 PM	S575285927194770

Message
Incubation prompt text as defined in the method step

[Acknowledge](#)

Fig. 79: Incubation Prompt

5.15 Method Modification

When a running assay is paused, the current executing method can be partially modified if the user has the “Modify Method During Run” permission. Limitations to modifications are as follows: no new method steps can be added, the loading pattern may not be altered, simulation times may not be updated; all other fields are normally able to be modified within a method step. Any modifications made to the method will be applied to all steps that have not yet begun processing; if a method step in an iteration has already started processing, then changes made will not be applied to that current iteration.

To modify a method on a running assay:

1. Pause the desired assay.
2. Navigate to the assay detail view, and click on the “Method” tab.

3. Click the “Unlock Modify Method” button.
4. Double click on the method step that needs to be updated and make modifications.
5. After all modifications are made, update the method in one of the following ways:
 - **Update Current Run:** Updates only the current run.
 - **Update Current Run & Method Template:** Updates the current run, and additionally updates the original method file.
6. Resume the run.

In addition to modifying method steps, users can also cancel individual steps using the “Cancel” button shown next to the “Save” button when editing a method step. A method step that has been cancelled is marked with a red icon on the method step graph and will not be executed for any iterations that have not yet run the step. Cancelled method steps can be restored using the “Restore” button displayed in place of the “Cancel” button. A method step that has been restored will be executed for any iterations that have not yet passed the step.

The cancellation markings created in this way are only saved for the method of the active run and take effect once the run is resumed. Saving cancellations to the original independent method file is not possible. Step cancellations or restorations are tracked in the assay run logs.

5.16 Security

The following role permissions are available to control access to Runtime features:

- **Abort Run:** Allows user to abort a run or plate(s) in a run.
- **Can Update Method Sim Times:** Allows the user to select method simulation times be updated from live run data after the run completes.
- **Delete Simulation:** Allows the user to delete any simulation.
- **Delete Run:** Allows the user to delete any run.
- **Lock Devices:** Allows user to Lock/Unlock devices.
- **Manage Scheduler:** Allows user to Restart, Suspend, or Resume the scheduler.
- **Manage Simulation Scheduler:** Allows user to Restart the simulation scheduler.
- **Manage Run Approval:** Allows the user to respond to approval prompts.
- **Manage Run Faults:** Allows a user to manage an error.
- **Modify Method During Run:** Allows the user to update/modify a method during run execution.
- **Pause/Resume Run:** Allows a user to pause or resume an individual assay run.
- **Reset Inventory on Run Start:** Allows the user to select the option to require re-inventory of all plates used in a Auto Generate Plate Association mode run.
- **Start Quick Read:** Enables the Quick Read special-purpose run.
- **Start Run:** Allows user to schedule a run.
- **Start Simulation:** Allows user to simulate a run.

- **Update Parameters During Run:** Allows the user to update method parameters during run execution.

6 Device Drivers

A Device Driver is distributed software that provides the bridge between FlowPilot and the physical lab device. Device Drivers are designed and provided by your Service Provider for supported devices. A driver can be started and stopped, as required, for error recovery, maintenance, or replacement of the physical hardware without having to stop the run or FlowPilot.

Device Drivers are implemented differently depending on device integration abilities.

- **Remote Web Application:** New drivers are implemented as web applications that can be viewed within FlowPilot in the Device Drivers menu item. Can be deployed on device workstation or on FlowPilot server as required.
- **Remote Application:** Older drivers and devices that do not support web-based integration. Can be deployed on device workstation or on FlowPilot server as required.

6.1 Manage Device Drivers

Users with required security permissions may manage the displayed device drivers using the Manage Device Drivers link in the Admin menu. A list of currently configured drivers will be displayed. The user can select to add a new driver or edit/delete an existing driver after selecting it. Additionally, the user can change the driver tab display order by dragging/dropping the row.

To add a new driver, a unique name and a valid URL are required. To display properly, the URL must be accessible from the user's machine, else the site will not be displayed.

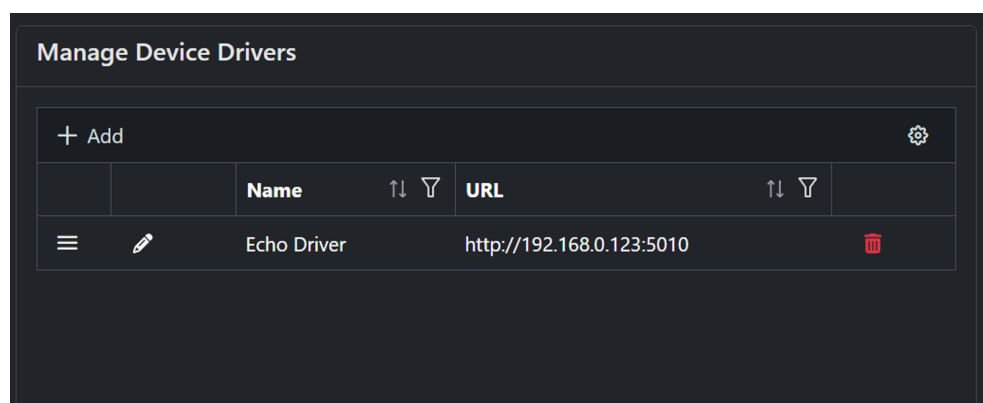


Fig. 80: Manage Device Drivers

6.2 Security

The following role permissions are available to control access to Device Drivers:

- **View Device Drivers:** Allow the user to view Device Drivers within FlowPilot. This will allow the user to execute any device action on the Device Drivers that is available.
- **Manage Device Drivers:** Allow the user to Add/Update/Remove configured Device Drivers.

7 Administration

7.1 User Management

User management is a core feature of FlowPilot. If a user is not logged into FlowPilot, they will be limited to viewing the following areas: run and simulation details, methods, and plate inventory. A logged-in user will have access to those areas granted by the role they are assigned.

7.1.1 Roles

Users with the Manage Users & Roles security permission may add, update, or delete roles. A list of existing roles will be displayed on the Role management page. An existing role may be edited, or a new role may be added. Roles may only be deleted if there are no users assigned to the role.

Role names must be unique. Permissions should be enabled to define the role for assigned users. When an existing role has been changed, users will need to log out and log back in for security changes to apply.

Role

Role Name*

Admin

Permissions

Assay Control	☒ Start Run ☒ Reset Inventory on Run Start ☒ Can Update Method Sim Times ☒ Start a Template ☒ Save a Template ☒ Abort Run ☒ Pause/Resume Run ☒ Manage Run Approval ☒ Manage Run Faults ☒ Update Parameters During Run ☒ Delete Run ☒ Start Quick Read ☒ Modify Method During Run
Lims Control	☒ Can View LIMS Jobs ☒ Can Start LIMS Job
Simulation Control	☒ Start Simulation ☒ Delete Simulation
Method	☒ Create & Update Methods ☒ Edit All Users Methods ☒ Can Create & Use Other Method Root Folders
Plate Inventory	☒ Use Plate Association Editor ☒ Edit All Users Plate Association Files ☒ Can Create & Use Other Plate Association Root Folders ☒ Upload Bulk Inventory ☒ Clear All Inventory ☒ Inventory Locations ☒ Move Plates ☒ Edit Barcodes ☒ Manage Stacker Groups ☒ Manage Inventory Allowable Plate Types
System Layout	☒ View System Layout ☒ Edit System Layout ☒ Modify Robot Locations ☒ Can Disable/Enable Device ☒ Initialize Device ☒ Change Simulation Mode ☒ Lock Devices
Documentation	☒ Manage Documentation ☒ View Advanced Documentation
General Administration	☒ Manage Application Settings ☒ Manage Config Support ☒ Manage Error Handling ☒ Manage License ☒ Manage Plate Types ☒ View Script Library ☒ Manage Script Library ☒ Manage Scheduler ☒ Manage Simulation Scheduler ☒ View System IO ☒ Manage System IO ☒ Manage Users & Roles ☒ Manage Webhooks ☒ View System Messages ☒ View Audit Log
Device Drivers	☒ Manage Device Drivers ☒ View Device Drivers
Integration Controls	☒ Allow Driver to Save Reports

Update Role

Reset

Fig. 81: Role Management

7.1.2 Users

Users with the Manage Users & Roles security permission may add, update, or delete users. A list of existing users will be displayed on the User Management page. A user may be edited or deleted, or a new user may be created.

The following fields must be completed for the user:

- **User Name:** Must be unique. Minimum of 4 and maximum of 10 characters.
- **First Name:** Maximum of 50 characters.

- **Last Name:** Maximum of 50 characters.
- **Email:** Maximum of 256 characters. Must be a valid email format.
- **Role:** Each user is granted one role.

When the role assigned to the user has been modified, the user will need to log out and log back in for security changes to apply.

If notifications have been enabled in FlowPilot settings, the Notification Settings section will be available. Users may select to receive email notifications when certain events occur in the system. For most notifications, the users can select if they want notifications for all system events, or just those events they created. If SMS has been enabled in the FlowPilot settings, the users may opt to receive the notifications via SMS instead of email.

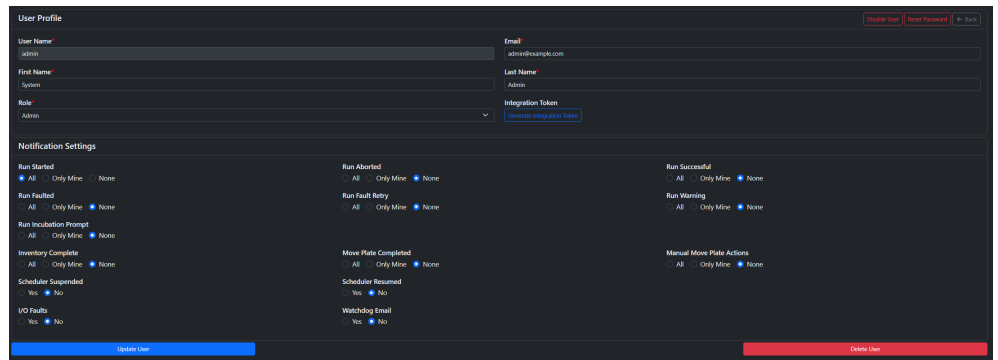


Fig. 82: User Management

7.1.3 Password Management

When a new user is created, a default password is assigned. The default password is stored encrypted in the database and can be changed by a user holding the Manage Users & Roles permission on the Settings page. A user holding that permission can reset the password of any user account to the current default password.

7.1.4 User Menu

After logging into FlowPilot, a user may click on the person icon in the upper right corner of the screen to view the User Menu.

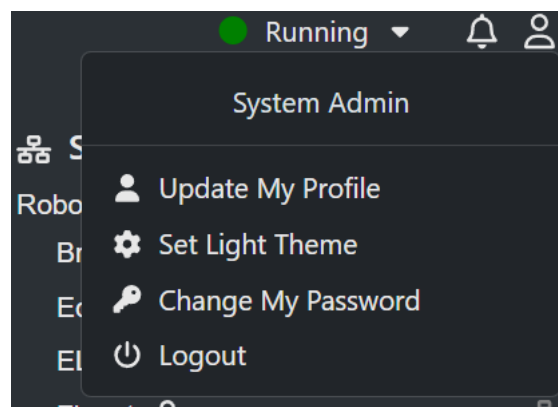


Fig. 83: Personal User Menu

7.1.4.1 User Profile

Once a user is logged into the system, they may view their profile to adjust their email, name, and Notification Settings if enabled.

7.1.4.2 Dark/Light Mode

FlowPilot supports the ability for the user to decide if they wish to use a dark or light theme.

7.1.4.3 Change Password

A user may manage their own password using the Change My Password feature in the user menu. By default, passwords must meet the following validation rules:

- Minimum of 8 characters
- Lowercase character
- Uppercase character
- Number
- Special character

The specific password requirements can be modified in the application settings file.

7.2 FlowPilot Settings

The following section describes the operation of the FlowPilot Settings. Changes to some settings are effective immediately while changes to other settings require the scheduler or the application to be restarted. The scheduler is always restarted when the application is restarted.

7.2.1 Scheduler Settings

These settings allow the administrator to modify how the scheduler responds during error recovery and processor loop rates. Changes to the Prevent Warning Prompt and Suspend on Fault settings become effective immediately. Changes to processor loop rates require the scheduler to be restarted.

- **Concurrent Assay Count:** Maximum number of assays that can execute at any given time. For unlimited, leave blank.
- **Prevent Warning Prompt:** Affects if the Warning Prompt is displayed to the operator. The effect of this setting is discussed thoroughly in Section 5.10.
- **Suspend Scheduler on Fault:** Affects the way the state of the scheduler is managed during error recovery. The effect of this setting is discussed thoroughly in Section 5.10.
- **Suspend Scheduler on Inventory Fault:** Suspends the scheduler when an inventory error occurs.
- **Resume Scheduler when Faults Cleared:** Automatically resumes the scheduler when all faults have been cleared by the operator.
- **Allow Auto-Display of Notifications and Faults:** Automatically display the Fault and/or Notification prompts to the user in the UI as they occur.

7.2.2 Inventory Settings

These settings allow the administrator to modify how inventory actions are completed in the system.

- **Inventory: No Plate Present Action:** Controls how FlowPilot will behave when an inventory is conducted, and no plate is present.
 - **None:** Inventory location is emptied and continues to next location.
 - **Notify:** Inventory location is emptied and continues to next location. A notification is sent to the operator.
 - **Error:** Stops the inventory and creates a fault notification. Operator must choose how to address the fault (retry, ignore, continue).
- **Inventory: Plate Present with No Barcode Action:** Controls how FlowPilot will behave when an inventory is conducted, a plate is present but a barcode can't be read (either no barcode, or it is unreadable).
 - **None:** FlowPilot generates a proxy barcode for the plate and updates the inventory.
 - **Notify:** FlowPilot generates a proxy barcode for the plate and updates the inventory. A notification is sent to the operator.
 - **Error:** Stops the inventory and creates a fault notification. Operator must choose how to address the fault (retry, ignore, continue).
- **Maximum Barcode Length:** Set the maximum length of barcodes that the customer uses. Prevents inadvertently creating inventory records that are longer than acceptable. Note: for Staubli robots, it is critical this is set the correct length as the controller code will only accept a specific size and will create issues if incorrect.
- **Maximum Simulated Barcode Length:** Should mirror the Maximum Barcode Length. Used when creating simulated barcodes.
- **Valid Simulation Barcode Prefix Length:** List of acceptable starting characters for barcodes when the robot is in simulation mode. Generally, only used during testing.

7.2.3 General Settings

These settings allow the administrator to modify general application settings that impact the display and operation of FlowPilot.

- **Use External Id for Run Folder:** If the customer uses the External Id field, will place all run associated files in a folder using the External Id value instead of the Run #. Useful to co-locate files from multiple runs for a single project.
- **Allow Run to Start with Mixed Inventory:** When set to No, requires all plates used in an Assay Run started in the Auto Generate Association mode to either be inventoried or not inventoried. Will clear inventory if mixed and re-inventory.
- **Require Plates Start in Home Position:** Requires all plates used in a run to start in their home location when an assay run is started.
- **Password Expiration Time (days):** Used to force users to change password on a set interval. Use -1 to indicate no forced change.
- **Date Format:** Used to specify the date format used in client-side display. Default is standard US format, change normally required for European based systems.

- **Allow Automatic Plate Recovery on Fault:** When set to Yes and an iteration is faulted, allows the operator to select automatic plate recovery which will move any plate still on a device from that iteration back to its home location.
- **Allow Integration Tokens:** When set to Yes, allows integration tokens to be used for machine-to-machine integration. Normally set to Yes.
- **Keep Task History:** Keeps detailed assay task records for troubleshooting purposes only. Should normally be set to No unless requested to be changed for debugging purposes.
- **Trace Files Enabled:** When enabled, FlowPilot will create a text-based Trace file for each iteration in the assay. Normally only set to yes for legacy customers that use these files.
- **Optimization Offset Factor:** Used to adjust the calculated plate introduction delay. Larger numbers will increase the delay. Only modify after consultation with Service Provider.

7.2.4 Auto-Barcode Settings

Auto-Barcode settings will enable the auto-barcode option when initiating an assay run. The user can set the Barcode Prefix and the starting Barcode Counter. The Barcode Prefix may be up to 4 characters in length. The starting Barcode Counter may be up to 6 digits, must be an even number, and must be 0 or greater. While running an auto-barcode assay, the Barcode Counter will increase by 2 for every plate that is processed.

7.2.5 File Locations

The user may change the name and location of certain file directories used by FlowPilot. Changes to these settings require a restart of FlowPilot.

- **System Layout File:** The system layout file for the given system.
- **Run Results Root Folder:** Location where all unique run folders with associated run files will be created. Default location is the “Run” folder located where FlowPilot is installed.
- **File Upload Root Folder:** Location where all uploaded files will be located. Default location is the “FileUploads” folder located where FlowPilot is installed.
- **Plate Association File Root Folder:** Location where all plate association files will be located. Default location is the “Assay” folder located where FlowPilot is installed.

7.2.6 Method File Settings

The method file settings section allows the administrator to change the root directory where method files are stored, and to enable method file tracking. Changes to the root directory require a restart of FlowPilot to take effect.

When Method File Change Tracking is enabled, a Git repository is created in the root method folder, and all changes are tracked. Organizations desiring to have a remote repository connected to the local repository can create an external job to push changes to the remote repository on the desired frequency. Please note that if the root folder location is changed, the Method File Change tracking will need to be disabled & saved, and re-enabled & saved for the new repository to be created.

7.2.7 UI Configuration Settings

Depending on how a system is used, certain elements may be removed from the schedule run screen if they will always be the same values or not used for the instance of FlowPilot. Changing these values will apply immediately to the Schedule Run and Simulate Run screens.

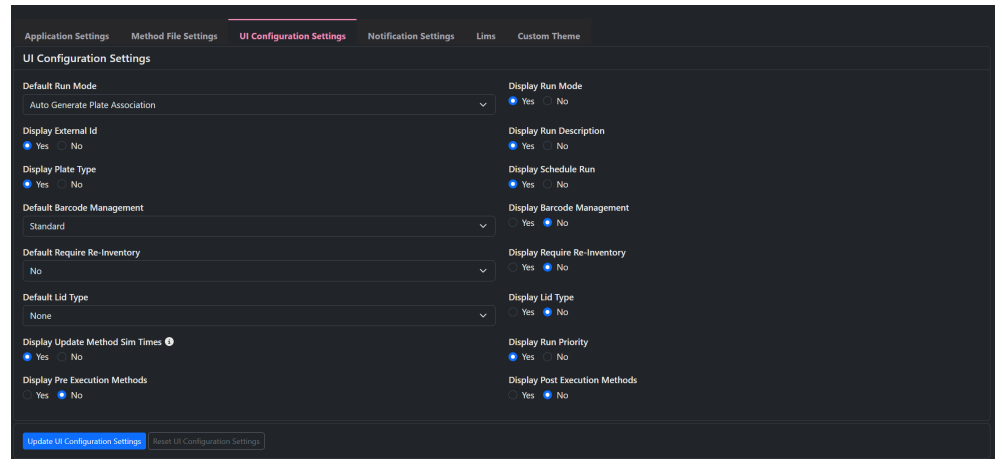


Fig. 84: UI Configuration Settings

- **Default Run Mode:** Set to the most frequently used Run Mode.
- **Display Run Mode:** If only one run mode will be used, set the default and hide.
- **Display External Id:** If no external project identifiers will be used, hide the field.
- **Display Run Description:** Normally set to hidden. Currently run description is not used within the system other than for tracking.
- **Display Plate Type:** If only a single plate type is used in the system, this is normally hidden.
- **Display Schedule Run:** If all assays will be run immediately, select No.
- **Default Barcode Management:** Most customers will use Standard.
- **Display Barcode Management:** Most customers will hide.
- **Default Require Re-Inventory:** Setting to Yes will delete the inventory in the selected starting location and re-inventory on the first plate movement.
- **Display Require Re-Inventory:** Select Yes if the user starting a run should be able to select if re-inventory of plates should be required.
- **Default Lid Type:** If only a single lid type/no lids on the system, set as default.
- **Display Lid Type:** If administrator wants the robot to always go through de-lidding process even if plates have no lids and hide/show as appropriate.
- **Display Update Method Sim Times:** If not displayed, runs will not update simulation times based on actual timings even if the user is allowed.
- **Display Run Priority:** If not displayed, all runs will have the same base priority.

7.2.8 Notification Settings

FlowPilot has the ability to send email or SMS messages to users when certain events happen, if enabled by the administrator. SMS messages are sent via email to the user, so email must be enabled to have the SMS option enabled. Please note that not all SMS providers support the required Email to SMS feature, and this feature is only available for US customers.

- **Email Enabled:** Set to Yes to setup notifications.
- **SMS Enabled:** Set yes to allow users to enter a phone number and provider and have notifications go to SMS instead of email.
- **SMTP Host:** Hostname of the SMTP server.
- **SMTP Port:** Port of the SMTP server.
- **Requires Authentication:** Set to true if the SMTP server requires a username and password authentication.
- **SMTP User Name:** User name to authenticate with.
- **SMTP Password:** Password to authenticate with.
- **SMTP Sender Email:** Email that will be used as the “From” address for all notifications.
- **SMTP Sender Display Name:** Display name of the notification sender.
- **SSL Enabled:** Set yes if the SMTP server requires SSL.
- **Validate SSL Certificate:** Set yes if the root certificates for the SMTP SSL certificate are installed and the SSL certificate is valid.
- **Watchdog Email Frequency:** Frequency of the watchdog email in minutes.
- **Watchdog Subject Name:** Used to differentiate between multiple FlowPilot instances at a single customer within Watchdog email.

7.3 Global Parameters

In the Global Parameters admin section, a user can create global parameters for use in methods. For each global parameter, its name, description, type and value can be defined. Additionally, the user can decide if the global parameter should be constant, which prevents its value from being modified outside of the global parameter section. The name of each global parameter must be unique. Any user can utilize the defined global parameters, but only users with the corresponding permission can manage them in the admin section.

Global parameters can be used in methods like existing assay or iteration scoped parameters. The names of local and global parameters must be unique even when compared between scopes. Any changes made to global parameters are tracked in the audit log.

Simulations can access global parameters, but they cannot modify the actual global parameters. Instead, when simulation(s) are started, a snapshot of the current global parameter values is taken and used. This way, simulations started as part of the same queue (group) can share values via global parameters without affecting the actual global parameters.

7.4 Script Library

In the Script Library admin section, a user can create predefined scripts for use in Script method steps. For each script, its name, description, language (C# or Python), script text and simulation time can be defined. Additionally, the user can decide if the script should be able to be cloned and modified as a local copy in a method step or if the script text should be inaccessible in the method step and the script should only be used exactly as it was defined. The name of each script must be unique.

Scripts are validated to be correct using the Validate button below the script text input, like in the Script method step. Changes to the script text of scripts is tracked in the database and past versions can be viewed, compared and cloned from the script library using the corresponding icon on each entry in the script library.

Users can be assigned separate permissions to view the script library and to manage/edit its entries. Users with the manage permission automatically have the view permission as well. Users with neither the view nor manage permission can still use predefined scripts as part of the Script method step, but they will not be able to see the script text of scripts unless they allow for local modifications.

7.5 System Messages

The System Message log displays all messages the scheduler produces that are not associated with an assay run. The log is primarily used for troubleshooting system issues.

7.6 System Status

I/O control is deeply integrated within FlowPilot. The System Status page displays any I/O that has been configured in the system. For example, monitoring equipment CO2 and Humidity readings from incubators, monitoring, and alerting when waste bottles are full, and supply bottles are almost empty. Monitoring can be used to trigger events, like pausing the system or sending an alert. I/O signals can also be tied to a variety of custom functions that expand your control of the system. All I/O data is logged, providing advanced tracking of every aspect of your system.

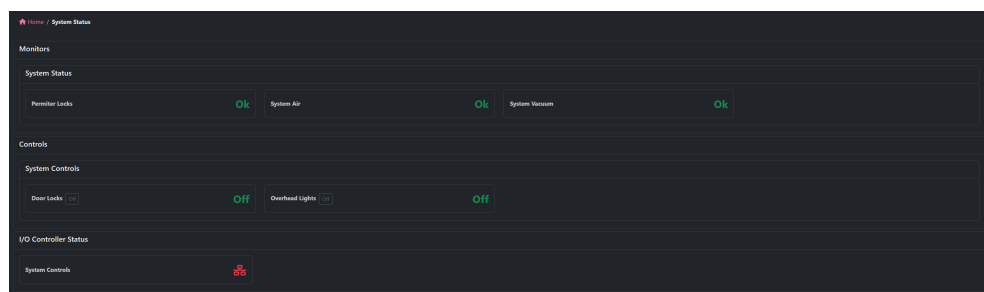


Fig. 85: System Status

7.7 Plate Types

Plate Types that will be used in the system must be defined in the Plate Type configuration. Plate Type data is used by the robot to properly grip the plate and move it safely between locations.

Administrators can optionally create Plate Type Groups to enhance the selection and display of plate types in FlowPilot. Plate Type Groups are created on the plate type setup page. Once a group has been created, the plate type can be created/updated with the appropriate group. Each plate type group may have a default plate type that can be used during method creation. Any plate type that does not have a plate group assigned will be added to the “Default” plate type group.

In addition to the core plate type options, plate types can be marked as non-disposable to prevent plates of the type from being disposed automatically as part of method executions. A plate can be set to be disposed in a method using, for instance, the Plate Disposal method step or the “Dispose After Use” option on a device method step. When a method configured with disposals in place is attempted to be run with plates of a plate type that has been set to prevent disposal, the run will be prevented from being started. When a plate type is modified to prevent disposal while an assay run using plates of the same type is in progress, disposals will also be prevented after the change is applied. The user will be notified by a warning message that the disposal of plates was prevented.

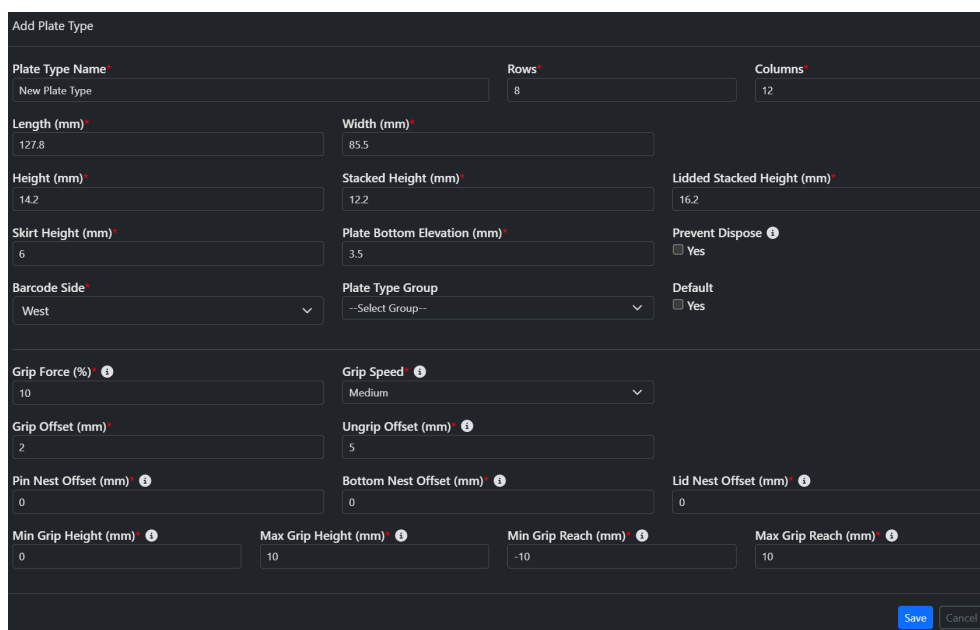


Fig. 86: Plate Type Setup

When creating a method, each plate may be assigned (optionally) a default Plate Type Group or a default Plate Type. If a Plate Type Group is assigned, the default within the chosen group will be automatically assigned as the Plate Type when scheduling a run; if no default is chosen, the first Plate Type in the group will be used instead.

7.8 Security

The following role permissions are available to control access to Admin features:

- **Manage Application Settings:** Allows the user to modify application settings.
- **Manage Error Handling:** Allows the user to add/edit/delete automation error handling rules.
- **Manage License:** Allows the user to update the system license.

- **Manage Plate Types:** Allows the user to add/update/delete Plate Types and Plate Type Groups.
- **Manage Scheduler:** Allows user to suspend, resume, and restart the scheduler.
- **Manage Settings:** Allows user to modify all FlowPilot settings.
- **Manage Simulation Scheduler:** Allows user to restart the simulation scheduler.
- **Manage System IO:** Allows the user to modify configurable I/O settings (e.g.: analog I/O monitoring).
- **Manage Users & Roles:** Allows the user to add/update/delete roles and users.
- **View System Messages:** Access to the general system message log.